DEPARTMENT OF MINES AND RESOURCES

Hon. T. A. Crerar, *Minister* Charles Camsell, *Deputy Minister*

LANDS, PARKS AND FORESTS BRANCH

R. A. Gibson, *Director*

CANADA'S WESTERN NORTHLAND

ITS HISTORY, RESOURCES, POPULATION AND ADMINISTRATION

Ottawa

J. O. PATENAUDE, I.S.O.

Printer to the King's Most Excellent Majesty

1937

DEPARTMENT OF MINES AND RESOURCES
Hon. T. A. Crerar, *Minister* Charles Camsell, *Deputy Minister*

LANDS, PARKS AND FORESTS BRANCH
R. A. Gibson, *Director*

CANADA'S WESTERN NORTHLAND

ITS HISTORY, RESOURCES, POPULATION AND ADMINISTRATION

Assembled by W. C. Bethune

OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1937

"Winter View of Fort Enterprize" by Lieut. Back, R.N., from a Copy of an Engraving in the Public Archives, Ottawa.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

39968—1½

LIST OF ILLUSTRATIONS—*Continued*

Canada's Western Northland

INTRODUCTION

CANADA'S WESTERN NORTHLAND is the second of two recent publications dealing with that part of the Dominion known as the Northwest Territories. The Northwest Territories embrace all of the mainland of Canada east of Yukon Territory north of the Provinces of Manitoba, Saskatchewan, Alberta, and British Columbia; all of the islands in Hudson and James bays and in Hudson strait including Ungava bay; and all of the Arctic islands north of the mainland of Canada. These northerly islands have been defined as those within the area bounded on the east by a line passing midway between Greenland and Baffin, Devon and Ellesmere islands, to the 60th meridian of longitude, following this longitude to the Pole, and on the west by the 141st meridian of longitude, following this longitude to the Pole.

The first of these two reports—CANADA'S EASTERN ARCTIC—was issued in 1934 and describes that portion of Canadian Arctic territory more accessible from the east than from other directions. The present publication covers the mainland portion of the Northwest Territories and the more southwesterly of the islands of the Arctic archipelago: principally Banks, Victoria, Prince of Wales, and King William islands. These two reports thus bring up to date and correlate available information relating to the Northwest Territories.

Within the past twenty years former impressions of the Northwest Territories have undergone considerable change. This change has been brought about by the ever-widening search for minerals and by the use of aircraft as a means of transportation and exploration. Once regarded as being almost inaccessible, many areas are to-day within a few hours' flying time of a number of cities and towns in Western Canada.

In spite of the northern latitude, the Territories are not entirely regions of perpetual ice and snow. The winter is long and cold but in the short summer the temperatures are high and the long periods of sunlight promote rapid growth of vegetation. In many places in the Mackenzie valley vegetables are grown for local consumption. The so-called "barren lands" yield a profusion of wild flowers and mosses and the northern limit of timber growth runs in a sweeping diagonal line from the mouth of the Mackenzie river, well north of the Arctic circle, to Churchill on Hudson bay.

Since the seventeenth century the Territories have been an important producer of furs, contributing 12½ per cent of Canada's production in 1935 and totalling upwards of $27,000,000 since 1922. The need of conserving the game and fur-bearing animals as a means of livelihood for the Indians and Eskimos of the Territories has always been borne in mind and large areas have been set aside as native game preserves.

The future of the Northwest Territories lies also in the development of its mineral resources. The most important development prior to 1929 was the bringing into production of two oil wells on the Mackenzie river near Norman. World attention was again turned to the Canadian Far North by the discovery of the pitchblende and silver deposits of Great Bear lake in 1930. The development of these deposits has been of importance not only because of the radium

and silver produced, but because of the inspiration it has given to prospecting and mining in the Territories by showing that large scale operations are possible in a region that was doubtfully regarded as a mineral country owing to the problems of distance and communication.

In spite of the difficulties arising from the widely scattered population every effort is made to take care of the health, education, and welfare of the native and white inhabitants of the Territories. Medical officers are maintained at the principal centres, where also are established day and boarding schools operated by religious bodies.

As exploration progresses and our knowledge of the North increases, a new and wider conception of the vast resources contained within the Northwest Territories will be obtained. In this publication an effort has been made to bring together available information on the western portion of the Territories to the end that interest may be quickened and pride increased in a part of the Dominion which for so long has been considered by some as being of little value in our economic life.

GOVERNMENT AND ADMINISTRATION

HISTORICAL

It is generally believed that the area comprising the western portion of the Northwest Territories as at present constituted, was first reached by Europeans shortly after the return to England in 1611 of the survivors of Henry Hudson's expedition to the great inland sea which now bears his name. Hudson does not appear to have touched or viewed the western shore of Hudson bay, at least not north of the 60th parallel of north latitude, which is the southern boundary of the mainland portion of the Northwest Territories. In 1612 Captain Thomas Button, who was later knighted, was placed in charge of an expedition to follow through to conclusion what was believed at the time to be Hudson's discovery of the Northwest Passage. Button sighted the west coast of Hudson bay at a point probably not far from where the Northwest Territories-Manitoba boundary line reaches the shores of the bay, and then turned south, wintering at the mouth of the Nelson river. The following summer he sailed north along the coast as far as Roes Welcome before returning to London.

Button was followed in 1631 by Captain Luke Foxe, who sailed north to Roes Welcome and then south along the coast. In the same year Captain Thomas James proceeded to the west side of Hudson bay and thence south to the lower end of James bay where he passed the winter. These two expeditions virtually quenched the hope of finding the Northwest Passage by way of Hudson bay proper although later expeditions did continue the search. It is probably necessary to mention only one of these here, that of Captain Christopher Middleton, 1742. Middleton failed, of course, in his effort to find a passage but by his careful exploration of the northwest portion of the Hudson Bay coast, he added considerably to the geographic information available on the area at the time.

The next event, in chronological order, of special interest in the history of the western Northwest Territories was the penetration of the interior by Samuel Hearne. After two false starts Hearne set forth from Fort Prince of Wales (now Churchill), on December 7, 1770, with a party of Chipewyan Indians. They travelled towards the west and north to a point east of lake Athabaska where they were joined by a large party of Indians on a war expedition against the Eskimos. They reached the mouth of Coppermine river in July but Hearne found it possible to carry out only a hurried survey of the river and he returned without finding the copper deposits, the rumoured existence of which was one of the principal reasons for his expedition.

About nineteen years after Hearne set forth from Fort Prince of Wales, Alexander Mackenzie, who was later to add to his laurels by a journey from Fort Chipewyan on lake Athabaska to the Pacific ocean, travelled the full length of that great western water route which now bears his name. In July, 1789, Mackenzie left Fort Chipewyan and travelled along Slave river to Great Slave lake where his party was held up temporarily by ice and lack of definite information as to the location of the outlet. Later the full length of Mackenzie river was explored without untoward incident, many Indian tribes which had never seen a white man being met along the way. The delta of the Mackenzie was reached about the middle of July.

The land expeditions of Sir John Franklin are frequently lost sight of by reason of the greater publicity given to his later, ill-fated search for the Northwest Passage, yet on these earlier expeditions Franklin and those associated with

him carried out the initial exploration of many of the inland waters and of the Arctic coast from a point in Alaska about 160 miles east of point Barrow to Kent peninsula, which is east of Bathurst inlet. On his first land expedition, begun in 1819, Franklin was accompanied by Dr. (afterwards Sir) John Richardson, Lieutenant (later Sir) George Back, and Lieutenant R. Hood. The party, after working westward from York Factory on Hudson bay to Fort Chipewyan on lake Athabaska and to Fort Providence on Great Slave lake, set out in August, 1820, for Coppermine river. Going by way of Yellowknife river, which flows south into Great Slave lake, they continued until the lateness of the season made it necessary to provide winter quarters. These were established on Winter lake and were given the name of Fort Enterprise.

The following July the mouth of the Coppermine was reached. Franklin and his men then travelled east along the Arctic coast to a point on the north side of Kent peninsula which was named Turnagain. Running dangerously short of provisions on the way back, Franklin decided to take a short cu. from Hood river to the previous winter headquarters.

In 1825, Franklin was placed in command of a second land expedition, and left England early in that year. The party, of which Dr. Richardson and Lieutenant Back were again members, proceeded down the Mackenzie to the mouth of the Great Bear river. At this point Back was sent to Great Bear lake to arrange winter quarters. Franklin went down the Mackenzie to its mouth and then returned to the quarters which had been erected under Back's direction on Great Bear lake, close to the outlet into Great Bear river. The following summer the party proceeded to the mouth of the Mackenzie where they formed into two groups. Franklin headed the party which examined the country to the west and Richardson had charge of the other which travelled to the east. Franklin continued along the coast for about 374 miles to a point which he named cape Beechey after the commander of a co-operating expedition by sea. At the same time the Richardson party explored the coast between Mackenzie and Coppermine rivers.

In 1833 Back was sent to search for traces of Captain John Ross' expedition by way of the sea which had not been heard of for some time. (Incidentally, Ross was frozen in off the east coast of Boothia peninsula. During his enforced stay in this locality Boothia peninsula and King William island were explored. A nephew, Captain James Clark Ross, located the Magnetic Pole on the west coast of Boothia.) Back, however, not knowing Ross' situation made his way to the east end of Great Slave lake where he built Fort Reliance and spent the winter. The next season he travelled north by a new route, going by way of Artillery, Clinton-Colden, and Aylmer lakes to the headwaters of Back river, formerly known as Great Fish river. He travelled this difficult watercourse to the Arctic coast and continued on to the northeastern point of Adelaide peninsula before returning.

In 1837 Thomas Simpson and Peter Warren Dease, working for the Hudson's Bay Company, completed the survey of the Arctic coast west of Mackenzie delta from the farthest point reached by Franklin to point Barrow. After wintering at Fort Confidence at the northeast angle of Great Bear lake, they descended the Coppermine and continued the survey of the Arctic coast for 100 miles east of point Turnagain. Still not satisfied they again wintered at Fort Confidence and the following season they "tied in" with Back's explorations, referred to in the preceding paragraph. On their return trip they examined the south shores of King William island and Victoria island.

The reconnaissance of the north coast of the mainland and of the southern coasts of the western Arctic islands was pretty well completed during the search for Sir John Franklin. Dr. John Rae, an officer of the Hudson's Bay Company, operating from a base established on Repulse bay, surveyed the remainder of Prince Regent inlet in 1847. Captain Richard Collinson in the *Enterprise* and

Captain Robert M'Clure in the *Investigator*, examined Banks island and the south and west shores of Victoria island during the years 1850-53. M'Clure after being forced to abandon his ship on the north side of Banks island made his way with the members of his expedition to Captain Kellet's ship which was participating in the search for Franklin and operating from the eastern side of the archipelago. M'Clure thereby completed the Northwest Passage although he did not get his ship through. Dr. Rae secured the first relics of the Franklin expedition in 1854 and in 1859 Lieutenant Hobson who, under and with Captain Leopold M'Clintock, was searching the shores of King William island, found the only written record left by the Franklin party so far discovered.

The search for new fur-trading territory was undoubtedly one of the primary motives for many of the foregoing explorations and the finding of promising accessible areas was quickly taken advantage of by the two great pioneer fur trading companies of northern and western Canada—the Hudson's Bay Company and the Northwest Company. This was particularly so along Mackenzie river. Under charter granted in 1670, the Hudson's Bay Company became virtually rulers of that vast, little-known, and inadequately described area, Rupert's Land. However with the signing of the deed of surrender in 1869, the company gave up rights granted under the original charter. Rupert's Land and the North Western Territory were transferred to Canada by Imperial Order in Council dated June 23, 1870.

In 1869 an Act for the temporary government of Rupert's Land and the North Western Territory when united with Canada was passed by the Canadian Parliament, and immediately upon the union taking place in 1870 a small portion of the newly acquired territory, including the Red River Settlement, was organized as the Province of Manitoba and admitted to Confederation. For the next five years the Lieutenant-Governor of Manitoba was also Lieutenant-Governor of the Northwest Territories.

In 1875 the Canadian Parliament passed the Northwest Territories Act, which provided for a more permanent form of government for the Territories. A resident Lieutenant-Governor was appointed and provision was made for the appointment of a Council of five which in time should be replaced by a Legislative Assembly with a maximum of twenty-one elected members. The seat of government was fixed for a time at Battleford and, while suitable buildings were being constructed, the first meeting was held on March 8, 1877, at Livingstone, near the present town of Swan River. The Council met in Battleford in 1878, 1879, and 1881, but owing to the rapid settlement along the Canadian Pacific Railway, the seat of Government was moved in 1883 to Regina.

Step by step, as settlement advanced and circumstances demanded, the further organization of the Northwest Territories was effected. The process involved the creating of various Districts, the fixing of the boundaries, and adopting of forms of administration, which were revised from time to time to keep abreast of development.

The District of Keewatin was created in 1876 and withdrawn from the Government of the Northwest Territories, the new district being governed by a Lieutenant-Governor and a Council of from five to ten members. The boundary of Manitoba was considerably enlarged in 1881. The Districts of Assiniboia, Saskatchewan, Alberta, and Athabaska were created in 1882, those of Ungava, Franklin, Mackenzie, and Yukon in 1895. Yukon was made a separate Territory in 1898. Adjustments of the boundaries of Quebec and Ontario were made from time to time.

About the beginning of the present century, with the increase of population, the demand of the people residing in the area comprising the present Provinces of Saskatchewan and Alberta for full provincial autonomy was met by the formation of the two provinces in 1905. The 60th parallel of latitude was declared the northerly boundary of the new provinces, which absorbed the

Districts of Assiniboia, Saskatchewan, Alberta, and Athabaska, the only districts having representation in the Northwest Territories Legislature.

For the remaining part of the Northwest Territories, the territorial form of government in force since 1875 was then discontinued and in its place provision was made by The Northwest Territories Amendment Act 1905, for the appointment, by the Governor General in Council, of a chief executive officer to be known as the Commissioner of the Northwest Territories, who would administer the government under instructions from time to time given him by the Governor General in Council or the Minister of the Interior. Provision was made for the appointment of a Council of four members or less, as deemed desirable, to aid the Commissioner. The seat of government was fixed at Ottawa. On September 1, 1905, the District of Keewatin was reannexed to the Northwest Territories.

Claims for a greater share of territorial lands were renewed by the older provinces of Quebec, Ontario, and Manitoba, and in 1912 the Dominion Government acceded to their requests. The boundaries of Quebec were extended to include all of Rupert's Land south of Hudson strait and Ungava bay and east of Hudson and James bays. Ontario and Manitoba were given the remainder of these lands on the south and west shores of Hudson and James bays as far as the 60th parallel of North latitude. Thus, by the year 1912, the original area of the Northwest Territories had been cut down to that of the present day.

By an Order in Council of March 16, 1918, becoming effective on January 1, 1920, the boundaries of the Districts of Mackenzie, Keewatin, and Franklin were revised and defined as now existing.

PRESENT GOVERNMENT AND ADMINISTRATION

The first Commissioner of the Northwest Territories under the re-arrangement of 1905 was Lt.-Col. Fred White who was also Comptroller of the Royal North West Mounted Police. Col. White was succeeded in 1920 by W. W. Cory, C.M.G., then Deputy Minister of the Interior. Mr. Cory was followed in 1931 by H. H. Rowatt, C.M.G., also Deputy Minister of the Interior at the time, who served as Commissioner until 1934. The Deputy Commissioner, R. A. Gibson, Assistant Deputy Minister of the Interior, acted as head of the Territorial Government until 1936, when Dr. Charles Camsell, C.M.G., Deputy Minister of Mines and Resources, was appointed Commissioner. Dr. Camsell was born at Fort Liard in the Mackenzie District, Northwest Territories.

After the Great War an increased interest in the resources of the Territories became quite apparent and provision for a more active administration was found necessary. By an amendment to the Northwest Territories Act in 1921 authority was granted to increase the membership of the Council to six and to designate one member as Deputy Commissioner. This was done immediately. A small field organization was also set up.

The Northwest Territories Council

The Northwest Territories Council is at present composed as follows:—

Commissioner: Dr. Charles Camsell, C.M.G., Deputy Minister of Mines and Resources.

Deputy Commissioner: R. A. Gibson, Director, Lands, Parks and Forests Branch, Department of Mines and Resources.

Councillors: Sir James H. MacBrien, K.C.B., C.M.G., Commissioner, Royal Canadian Mounted Police; Dr. Harold W. McGill, Director of Indian Affairs Branch, Department of Mines and Resources; K. R. Daly, Senior Solicitor, Department of Mines and Resources; Austin L. Cumming, Superintendent of Mackenzie District, N.W.T., and Secretary of Yukon Affairs.

Secretary: D. L. McKeand, Superintendent, Eastern Arctic.

The Council meets throughout the year whenever the business on the agenda warrants. It functions not only as a legislative body but in an advisory capacity to the Minister of Mines and Resources on matters pertaining to the administration of the Northwest Game Act, and the various Ordinances which have been passed from time to time. Careful consideration is given to the well-being of the resident population, white and native. Appreciation of the fact that natives must, by reason of character, training and environment, depend almost entirely on hunting and trapping for a livelihood is reflected in the game regulations and the large areas set aside as game sanctuaries and native game preserves.

Responsibilities of Council

The Northwest Territories Act provides that the Northwest Territories Council shall have the same powers to make Ordinances for the government of the Territories as were on August 31, 1905, vested in the Legislative Assembly of the Territories in relation to such subjects then within the legislative authority of the Assembly as are from time to time designated by the Governor General in Council. The Act goes on to specify, without restricting, certain classes of subjects which may be so designated, such as: education; the solemnization of marriage; property and civil rights; the issue of licences to explorers or scientists to enter the Territories to carry out certain investigations; the levying of taxes on furs shipped out of the Territories, etc. The Act also stipulates that the Commissioner in Council shall not have greater powers than are given to provincial legislatures under the British North America Act, 1867, and, that all Ordinances made by the Commissioner in Council shall be laid on the tables of both Houses of Parliament as soon as possible.

Administration of Justice

Subject to the provisions of the Northwest Territories Act, the laws of England relating to civil and criminal matters as they existed on the fifteenth day of July, 1870—the date on which Canada took over the administration of the Territories from the Hudson's Bay Company—are in force in the Territories in so far as they are applicable or have not been repealed or modified by an Act of the Parliament of Great Britain or of the Parliament of Canada; and every Act of the Parliament of Canada, except as otherwise provided, is in force in the Territories in so far as it is applicable. The local legislation is enacted by Orders of the Governor General in Council and Ordinances of the Northwest Territories Council

In addition to subjects previously mentioned, the legislative powers of the Commissioner in Council are extended to such matters as the constitution, organization, and maintenance of Territorial courts of civil jurisdiction, the imposition of punishment by fine, imprisonment, or other penalty for enforcing Territorial Ordinances, and generally all matters of a local or private nature in the Territories. Provision is made in the Northwest Territories Act for the appointment by the Governor General in Council of stipendiary magistrates. The stipendiary magistrates may, in a summary way, try such charges as minor thefts, unlawful wounding, and certain types of assault. Other charges are tried with the intervention of a jury of six unless the accused elects to be tried by the stipendiary magistrate in a summary way. The Governor General in Council may also appoint Justices of the Peace having the jurisdiction and powers of authority of two Justices of the Peace, which, generally speaking, gives such an appointee the authority of a magistrate.

The Agent of the Department of Mines and Resources at Fort Smith is a Stipendiary Magistrate, and all commissioned officers of the Royal Canadian Mounted Police are Justices of the Peace for the Northwest Territories with the powers of two Justices of the Peace.

For the administration of estates of deceased persons there are two Public Administrators, one for the Mackenzie District with headquarters at Edmonton, and the other for the Keewatin and Franklin Districts with headquarters at Ottawa.

The Commissioner of the Royal Canadian Mounted Police is Sheriff of the Northwest Territories and the Royal Canadian Mounted Police is the force responsible for the maintenance of law and order throughout the Territories. The policing of such an immense area by such a small body of men is only possible through the adequate training of specially selected men. Police posts are located at strategic points and the intervening territory is covered by patrols both winter and summer. Under the Northwest Game Act the Police are ex-officio game officers. They also carry out many duties connected with the administration of the Territories where there are no other government officers specially charged with these responsibilities. As the members of the Force become more experienced in determining the type of data wanted, the patrol reports each year are becoming more comprehensive and of greater value to the Government of the Territories and to scientists and other investigators studying the resources of the Territories.

The present strength and distribution of the Royal Canadian Mounted Police in the western portion of the Northwest Territories is as follows:—

Detachment	Officers	Other Ranks
Fort Smith	1	4
Resolution	–	3
Providence	–	2
Simpson	–	3
Norman	–	2
Good Hope	–	2
Arctic Red River	–	2
Aklavik	1	4
Maitland Point	–	2
Coppermine	–	2
Cambridge Bay	–	2
"St. Roch" (floating)	–	9
Cameron Bay	–	2
Fort Rae	–	2
Reliance	–	3
Chesterfield	–	3
Eskimo Point	–	2

MISSIONS, SCHOOLS, HOSPITALS

Missionary work, education, and hospitalization in the Northwest Territories are very closely interwoven by reason of the fact that all schools and hospitals in the Territories are owned by the Roman Catholic or Anglican missions, and are operated with the assistance of grants of money and school and medical supplies from the Dominion Government. These churches first sent their missionaries into the Mackenzie River district about the middle of the nineteenth century and the work of educating the Indian children commenced shortly afterwards as one of the first steps in the conversion of the aborigines of the district. In addition to the subjects usually taught in primary schools special attention is given to manual and domestic training, and hygiene.

Eskimo children are educated in schools in Eskimo territory; white, half-breed and Indian children in schools located as closely as possible to their homes. While it may be said that wherever a missionary is located some educational work is carried on, schools are conducted regularly by the missions as follows:—

Day Schools

Fort Smith (R.C.), Fort Smith.
Fort Smith (Ang.), Fort Smith.
St. David's (Ang.), Simpson.
Simpson (R.C.), Simpson.
Holy Trinity (Ang.), Norman.
St. Matthew's (Ang.), McPherson.
All Saints' (Ang.), Aklavik.
Baker Lake (Ang.), Baker Lake.
Cambridge Bay (Ang.), Cambridge Bay.
Chesterfield (R.C.), Chesterfield.
Coppermine (Ang.), Coppermine.
Eskimo Point (Ang.), Eskimo Point.

Residential Schools

St. Joseph's (R.C.), Resolution.
St. Peter's (Ang.), Hay River.
Sacred Heart (R.C.), Providence.
Mary Immaculate (R.C.), Aklavik.
All Saints' (Ang.), Aklavik.

New Anglican Residential School at Aklavik

This school replaces one that was maintained principally for Eskimo pupils, at Shingle Point on the Arctic Coast, and accommodates white, Eskimo, and Indian children.

Medical Services

Full-time medical health officers are maintained by the Department of Mines and Resources at Aklavik, Norman, Simpson, Resolution, Fort Smith, and Chesterfield, with a part-time medical health officer at Cameron Bay. The doctor at Cameron Bay is called upon to give special attention to the health of those working with radium-bearing ores. The Government also provides graduate nurses for the hospitals and residential schools maintained by churches at Fort Smith, Resolution, Hay River, Providence, Simpson, Aklavik, and Chesterfield.

The Government makes a per diem allowance for the treatment of Eskimos, Indians, and indigent white and half-breed patients in hospitals which have been established as follows:—

All Saints' (Ang.), Aklavik.
R.C. Mission (R.C.), Aklavik.
St. Therese (R.C.), Chesterfield.
General (R.C.), Fort Smith.
St. Peter's (Ang.), Hay River.
St. Marguerite's (R.C), Simpson.

Radio and aircraft extend to a large degree the field of influence of these medical centres. In addition all Government officers, including Royal Canadian Mounted Police detachments, are provided with first-aid equipment.

Operating Room in Roman Catholic Hospital at Fort Smith

GEOGRAPHY*

The area covered by this report consists of part of Canada's mainland lying north of the 60th parallel of latitude between Yukon Territory and Hudson bay, together with Victoria, Banks, Prince of Wales, and King William islands, and contains more than 900,000 square miles as follows:—

	Square Miles
District of Mackenzie	527,490
District of Keewatin	228,160
Victoria island	79,269
Banks island	25,992
Prince of Wales island	14,004
King William island	4,961
Boothia peninsula	12,960
Melville peninsula	24,156
Total	916,992

The mainland is dominated by two topographical features—the Laurentian plateau, which extends from the southeast and occupies the greater part of the area westward of Hudson bay to the valley of Mackenzie river; and the Mackenzie lowland, which is a northward continuation of the great central

Relief Map of Northern Canada

* By C. S. Macdonald, Department of Mines and Resources.

plain. The plateau region has a rocky irregular surface with a relief rarely exceeding a few hundred feet, and on its generally treeless surface there are many lakes and muskegs drained by small rivers. The forested surface of the Mackenzie lowland, has a gentle slope to the northwest. On its western boundary are the Mackenzie mountains with Keele peak, 8,500 feet high, near their centre.

Apart from the aeroplane service, the only organized transportation routes into the area are, from the west, the sea-lane from the Pacific through Bering strait: from the east, the waterway from the Atlantic through Hudson strait and bay, and from the south, the Mackenzie River system. Many canoe routes are navigable during the open season but in considering any of these one should give careful study to season, supply of provisions, maps, and perhaps most of all, the personnel of the party.

MACKENZIE LOWLAND

The Mackenzie lowland is roughly divided by the Franklin and Horn mountains into the Mackenzie River valley and a low-lying depression extending from Great Slave lake northward to Great Bear lake. North and northeast of Great Bear lake there is a low divide separating the waters of Great Bear lake from those flowing into the Arctic ocean.

The Mackenzie River Valley

The Mackenzie River system in the Northwest Territories consists of part of the Slave river, Great Slave lake with its many tributaries, Great Bear lake, and Mackenzie river. The Mackenzie proper is that part of the system flowing northward from Great Slave lake to its outlet in the delta on the Arctic coast, a distance of over 1,000 miles.

Many rivers, their valleys extending far back into the mountains, pour their waters into Mackenzie river from the west. The North Nahanni, Keele (formerly called Gravel), and Arctic Red rivers all drain from the eastern slope of the Mackenzie mountains. The Peel, flowing from the south and west, empties into the Mackenzie delta near McPherson. The Liard, the greatest of all the Mackenzie tributaries from the west, has its southern headwaters in British Columbia and drains the slopes of the Mackenzie mountains in Yukon Territory. The more important tributaries from the east are Great Bear, which is the outlet for Great Bear lake; Hare Indian, and Thunder rivers.

The Mackenzie River route is one of the finest natural water routes in Canada. It consists of part of the Athabaska river, lake Athabaska, Slave river, Great Slave lake, and Mackenzie river, traversing the Mackenzie District from south to north. On it one may travel in the comfort of a modern steamer a distance of over 1,600 miles from the end of steel at Waterways, Alberta, to the Arctic ocean with but one interruption—the rapids between Fitzgerald and Fort Smith The round trip occupies thirty-three days.

Weekly train service, which includes dining and sleeping car accommodation, leaves Edmonton for Waterways, on Tuesday morning and the traveller can be in Fort Smith, N.W.T. the following Saturday. From Waterways a steamer proceeds down the Clearwater and Athabaska rivers and across the west end of lake Athabaska to Chipewyan. From here the route is down the Slave river to Fitzgerald ninety-three miles distant. Over a road sixteen miles long, passengers and freight are moved by motor transport to Fort Smith, established by the Hudson's Bay Company in 1879. Here are located trading posts, missions, office of the Agent of the Department of Mines and Resources, Royal Canadian Mounted Police detachment, post office, mission hospital, day schools, and

wireless station. The traveller is now in the Northwest Territories, the southern boundary of which is close to the south side of Fort Smith settlement. To the west and south of Fort Smith lies Wood Buffalo Park, part of which is in the Northwest Territories.

Fort Smith to Simpson

From Fort Smith the route is down Slave river for 200 miles. The character of the river changes below Fort Smith, the rock exposures disappear and the river, sometimes more than 80 feet deep, runs through an alluvial plain on which there is a good growth of timber, spruce predominating, and a heavy growth of underbrush. The channel changes from time to time, numerous sandbars and islands appear, and on some of the latter good spruce is seen. A delta is formed where Slave river enters Great Slave lake.

The first port of call on Great Slave lake is Resolution, located a short distance south of the delta of Slave river, which enters the lake from an easterly direction. Resolution was established by the Hudson's Bay Company about the beginning of the nineteenth century. It has, in addition to the houses of its Indian residents, a wireless station, post office, mission, residential school, Royal Canadian Mounted Police detachment, and trading posts.

Proceeding along the low south shore of Great Slave lake, a distance of 75 miles, the route leads to Hay River, established by the Hudson's Bay Company in 1870. At Hay River, located on the right bank of Hay river where it enters Great Slave lake, there are a mission, hospital, residential school, trading post, and post office. Hay river enters Great Slave lake from the southwest and for 185 miles, from Hay River Settlement to Upper Hay River Post, is navigable by canoes. From Upper Hay River a wagon road leads across to Fort Vermilion on Peace river. The most beautiful and interesting features are Alexandra and Louise falls of 140 and 52 feet respectively, situated 44 miles upstream from Great Slave lake.

Leaving Hay River and continuing across Great Slave lake in a northwesterly direction, Mackenzie river is entered on the south side of Big island, 34 miles from Hay river. Between Resolution and the west end of the lake, the south shore is low and shelving and the forest growth small and scrubby.

Forty-four miles down the Mackenzie, Providence is located on the right bank of the river. Here is also a trading post, post office, mission, residential school, and Royal Canadian Mounted Police detachment. The fort built by Alexander Mackenzie in 1790 at the mouth of Yellowknife river on Great Slave lake was also called Fort Providence but it was abandoned shortly afterwards. It was later moved to a point on the north arm of the lake and the name changed to Rae. The present fort on Mackenzie river was established by the Hudson's Bay Company about 1850. From Providence downstream 89 miles to what is known as the "Head of the Line," the river is from one mile to two miles wide and the banks are low and swampy. From the "Head of the Line" to Simpson, a distance of 67 miles, the river narrows and varies from a quarter of a mile to half a mile in width except for about six miles above Simpson, where it gradually widens to a mile. This section of the river is known as the "Line" from the fact that before the days of steamers, the scows, York boats, and canoes, had to be tracked on the upstream journey. The banks are high and in many cases abrupt. The current is from 6 to 8 miles per hour and the channel is from 40 to 50 feet deep.

The distance from Providence to Simpson is 156 miles and Simpson is 821 miles from Waterways. Simpson, which is located on a large island, was established in 1820 by the Northwest Company and called Fort of the Forks. After the union with Hudson's Bay Company this name was changed in 1850 to Simpson. At Simpson, which is an important point on the route, there are a wireless station, hospital, mission, day schools, trading posts, post office and Royal Canadian Mounted Police detachment.

Just before reaching Simpson, the mouth of Liard river, which empties into the Mackenzie from the southwest is seen. This is the largest tributary of the Mackenzie and its mouth is as wide as the Mackenzie itself at this point.

One trip a year is made by a motor boat up the Liard to Fort Nelson on Fort Nelson river in northern British Columbia. Going up Liard river, South Nahanni river enters the Liard from the north, 110 miles from the Mackenzie and 90 miles farther upstream, Liard post is reached. This post, established by the Hudson's Bay Company in 1890, is on the right bank of the Liard near the mouth of Petitot river. Here, in addition to the trading post, there is a detachment of the Royal Canadian Mounted Police. Between the mouth of the South Nahanni and Liard post the river is some 400 to 500 yards wide and has a current of about 4·5 miles per hour. There are many sandbars and islands which divide the river into numerous channels, and in the lower portion of the river there is practically no valley. The comparatively flat country along the banks is well wooded with white spruce and poplar, with some jack pine and canoe birch.

South Nahanni river may also be ascended. Ninety-two miles from where it enters the Liard, is "The Gate," a narrow box canyon. Eighteen miles farther upstream, Flat river, the main tributary of the South Nahanni, enters from the

"The Gate", a Box Canyon on South Nahanni River

This aerial view was taken 92 miles above Liard river. South Nahanni river rises in the Mackenzie mountains, part of which can be seen in the background.

west, and 15 miles beyond this point are the Virginia falls. These falls have a drop of 316 feet and a width of about 350 feet. There are no portages on South Nahanni river below Virginia falls, but the river is very rapid and on the upstream journey much tracking is necessary. Above Virginia falls the river appears to be more regular and navigation is better. The scenery along the South Nahanni from the Liard river to Virginia falls is very wild and beautiful.

Simpson to Norman

Returning to Simpson the route continues down the Mackenzie a distance of 152 miles to Wrigley, a small trading post built by the Hudson's Bay Company in 1880. On this stretch the width of the river is from half a mile to three and three-quarter miles and the current runs from 3 to 7 miles per hour. The banks vary greatly in height, ranging from 10 to 400 feet. Eighty-seven miles from Simpson, near the entrance of Root river, a bare rock escarpment 3,000 feet high can be seen to the west. Seventy-three miles below Simpson, North Nahanni river enters from the west. From midway between Simpson and Camsell bend the first glimpse is caught of the mountains—Mackenzie mountains to the west and Franklin mountains to the east. One of the best views is obtained from Camsell bend. Between Wrigley and Norman, a distance of 150 miles, the banks vary from 100 to 300 feet in height, from 10 chains to half a mile inland. They are well wooded except for some large brûlé areas. The largest stream entering this stretch of the Mackenzie is Keele river, 98 miles below Wrigley. The current is from 4 to 8 miles per hour and the channel from Blackwater river, 51 miles below Wrigley, to Old Fort point, 66 miles farther down-stream, is from 36 to 50 feet deep.

Norman, one of the most important posts on the river, was established in 1810 by the Northwest Company, moved upstream about 30 miles to Old Fort point in 1844, and moved back again in 1851. It is situated on the right bank of the Mackenzie and the left bank of Great Bear river, which enters here from Great Bear lake. Here there are trading posts, post office, Royal Canadian Mounted Police detachment, mission, day school, and wireless telegraph station. At this point, in addition to Norman traffic, all water-borne freight and passengers for Great Bear lake are transferred from the Mackenzie River route. Bear Rock, which rises 1,300 feet above Mackenzie river, is located on the north bank of Great Bear river and on the east bank of the Mackenzie. It is an excellent landmark which can be seen from a great distance.

From Norman, Great Bear lake may be reached by ascending Great Bear river a distance of 75 miles. About half way between the lake and the Mackenzie, the river passes through Franklin mountains, and in this section St. Charles rapids are situated. These rapids interrupt water navigation, and a road has been constructed on the south side of Great Bear river to facilitate the handling of freight and as a safety factor in case the water should drop too low to enable shallow-draught boats to navigate the rapids. The site of Fort Franklin is distant about four miles northeasterly from the point where Great Bear river leaves the lake. It was established by the Hudson's Bay Company for Sir John Franklin in 1825, and to-day there is an Indian settlement and trading post near this point. The straight-line distance from Great Bear river across the lake to Cameron Bay is 172 miles, while in following the south shore with small craft the distance is about 210 miles.

Norman to Arctic Red River

On Mackenzie river, from Norman to Good Hope, the distance is 171 miles. The river is from half a mile to three and a half miles wide, and the current from 2 to 5 miles per hour, except at the head of The Ramparts where it reaches a velocity of 6 miles per hour. The banks are from 100 to 200 feet high. Leaving Norman, the first things of interest are the oil wells 51 miles downstream, where gasoline and oil are being produced for local consumption.

The Sans Sault rapids, 120 miles below Norman, are in the eastern portion of the stream and extend about one-third of the way across the river, the steamer channel being nearer to the west side at this point. Forty-one miles farther downstream is one of the most picturesque parts of the river, known as The Ramparts. This feature might more properly be called a canyon or gorge. For seven miles the river runs between perpendicular cliffs of limestone from 100 to 200 feet high. It is about half a mile wide at the upper end and slightly wider at the lower. Alexander Mackenzie found the depth of the channel near the upper end to be 300 feet. This great depth probably accounts for the fact that the current is only about 3 miles per hour.

On leaving The Ramparts, Good Hope is seen immediately in front, set up high on the right bank of the Mackenzie. Good Hope was established by the Northwest Company in 1804, about 100 miles below its present site. After the

Aerial View of Good Hope

union of the Northwest Company and Hudson's Bay Company in 1821, it was moved to Manitou island, opposite the present site. In 1836 it was destroyed by ice and rebuilt on its present location. Here are found a trading post, Royal Canadian Mounted Police detachment, and a post office.

The longest stretch of river between two trading posts, 214 miles from Good Hope to Arctic Red River, is now entered. Along this part of the Mackenzie, the river's width varies from half a mile to three and a half miles. There are many islands below Good Hope. In the lower 75 miles the river is of more uniform width, about a mile and a quarter. On the right bank 40 miles below Good Hope there are limestone cliffs 250 feet in height, backed by hills 500 to 1,000 feet high. At other places the banks attain a height of 300 feet, but for the most part they are low and the adjacent country swampy. For seven miles before Arctic Red River is reached the river passes through what is called the Lower Ramparts. The banks are of shale ranging up to 300 feet in height. Immediately below the Lower Ramparts, is located Arctic Red River post, built

by the Hudson's Bay Company in 1900. It is situated on the left bank of Mackenzie river and on the right bank of Arctic Red river, where it empties into the Mackenzie. At Arctic Red River there are, in addition to the houses of the Indian population, a trading post, post office, and a detachment of the Royal Canadian Mounted Police.

Arctic Red River to Aklavik

Fifteen miles farther downstream is the head of the Mackenzie delta and twelve miles below this the mouth of Peel river, which enters from the west, is reached. Twenty-eight miles up the Peel is McPherson post established by the Hudson's Bay Company in 1840. The post is on the east side of the river on a high bank of shale, outcroppings of which can be seen near the river. There is a trading post, post office, day school, and mission located at this point.

From McPherson on Peel river, a route leads to Fort Yukon at the junction of Porcupine and Yukon rivers in Alaska. Thirteen miles below McPherson, Rat river is ascended about 50 miles to a creek coming into Rat river from the west. This is ascended to its headwaters and three small lakes take one across the height of land to another creek down which the route leads to Bell river. The distance between Rat and Bell rivers is about 14½ miles. Twenty-one miles down Bell river the site of Lapierre House, built by the Hudson's Bay Company in 1847 and abandoned in 1890, is reached and another 30 miles down Bell river Porcupine river is entered, down which the route leads to Rampart House, 157 miles from Bell river. This is the first trading post after leaving McPherson. From Lapierre House to Rampart House usually takes about four days. From Rampart House to Fort Yukon, the distance is about 150 miles and the trip takes about three days. On this entire trip from McPherson to Fort Yukon, no portages exist but considerable tracking may be necessary.

Aklavik to Mouth of Mackenzie River

Aklavik is the next point of call on the Mackenzie route and to reach it the practice is to follow either Peel channel or the Middle and Aklavik channels to the settlement. Aklavik is about half-way through the delta and on its western side. From the upper point of the delta to the coast, the area is broken up by innumerable channels, lakes and ponds; in fact it is a veritable maze of waterways. The stream is bordered by low-cut banks and there are some stands of spruce in the delta, with trees up to 12 and 14 inches in diameter. At Aklavik there is a considerable settlement which includes a Medical Officer, who acts as Administrative Agent for the Western Arctic, a Royal Canadian Mounted Police detachment, Anglican and Roman Catholic Missions, residential and day schools, hospitals, wireless station, post office, and trading posts.

From Aklavik, which is normally the northern terminal of navigation for river steamers, to Kittigazuit, a distance of 169 miles, the route is through the maze of waterways until the East channel is reached and followed to Kittigazuit which is on the Arctic coast at the mouth of this channel. The post here was established by the Hudson's Bay Company in 1915 and abandoned in 1929. The route through these channels is also the one taken to reach the Hudson's Bay Company's new trading post and transport depot, Tuktoyaktuk*, some 20 miles east of Kittigazuit on the coast. Here the motor vessels meet the sea-going craft, which distribute freight along the Arctic coast, as far east as King William island.

By following the West and Anderton channels a distance of 69 miles, the traveller will also arrive at the Arctic coast. From the mouth of this channel to Shingle Point is a distance of 41 miles and to Herschel island, 106

* *A recent decision of the Geographic Board of Canada changed the name to Port Brabant*

miles. Herschel island was early a whaling and trading rendezvous for ships in the whaling industry in Beaufort sea. The Hudson's Bay Company established its first post at Herschel island in 1915 but both the Royal Canadian Mounted Police and the Anglican mission were located at this place prior to that time. At present (1937) there are: a trading post, Royal Canadian Mounted Police detachment, a wireless station (during navigation), and a mission.

Great Slave Lake to the Arctic Coast at Mouth of Anderson River

Great Slave lake lies about 210 miles southeast of Great Bear lake and is nearly as large, having an area of 11,170 square miles. It is 348 miles long from the site of old Fort Reliance at the northeastern extremity to its outlet—Mackenzie river—at its southwesterly end, measured along the schooner channel. The width from the Slave River delta northwesterly to Gypsum point is 50 miles. Many fair-sized rivers empty into Great Slave lake: on the south, Taltson, Slave, Buffalo, and Hay; on the east, Lockhart river, which drains the area as far east as Artillery lake, and the Snowdrift; and on the north, Yellowknife, Marian, Beaulieu, and Francois.

The elevation of Great Slave lake is 495 feet above sea level, and the distance to the Arctic ocean is 1,054 miles. This gives an average fall of less than half a foot to the mile. The water in the eastern portion is clear, deep, and cold, about 10° F. colder than the water in the western portion where the lake is more open and shallow. At certain seasons the water in the western part is quite muddy due to the inpouring of the silt-laden waters of Slave river. The shores at the east end are bold, rocky, and very picturesque whereas to the west they are low and swampy.

From Resolution on Great Slave lake one can travel by motor boat to Rae on Marian lake just north of the north arm of Great Slave lake, a distance of 150 miles, and on to Reliance at the east end of the lake. From Rae a canoe route leads to Great Bear lake, and from Reliance one may travel by canoe easterly to Hudson bay, northeasterly to Back river and on to the Arctic coast at Chantrey inlet, or northerly to the headwaters of Coppermine river which can be followed to the Arctic coast at Coppermine.

The route from Resolution to Rae is in a northwesterly direction across Great Slave lake to Hardisty island, a distance of 52 miles; thence north and northwest up the north arm to Whitebeach point, 112 miles from Resolution. From here the route passes to the northeast side of Waite island, 14 miles distant, then close to the site of old Fort Rae at Rae point, 7 miles from Whitebeach point, and on to the entrance of Frank channel connecting Great Slave lake with Marian lake. Two miles from Frank channel, on the east side of Marian lake, is located Rae where, in addition to the trading posts, there is a mission, and a Royal Canadian Mounted Police detachment.

From Rae, the canoe route leading to Great Bear lake is about 350 miles long and necessitates some 46 portages. Generally this route follows the line of demarcation between two entirely different types of country: that to the east being a country in which there are many lakes and waterways, while the country to the west is comparatively dry. The route lies up Marian river and through a valley running north-northwest from Rae to Conjuror bay on Great Bear lake in which valley Marian river, a chain of lakes, and Camsell river form the canoe route. In that section west of the canoe route from Rae to Great Bear lake, areas of high rolling country with tablelands of limestone predominate. Lac la Martre lies between Great Slave and Great Bear lakes. It is approximately 60 miles in length and discharges by la Martre river into Marian river, 40 miles north of Rae.

Great Bear lake is the largest body of fresh water lying entirely in Canada, its area being 11,660 square miles. The lake is deep and the water is of a strikingly transparent green colour and is always very cold and clear. Although

Great Bear lake is such a large body of water, no outstandingly large rivers flow into it. Camsell river on the southeast, and Dease and Sloane rivers on the northeast, are the principal contributors to its waters. Its outlet is the Great Bear river, emptying into Mackenzie river at Norman.

East of the Mackenzie river and north of Great Bear lake is a large tract of country drained by Anderson river, which flows northwards to the Arctic ocean. In it there are no outstanding topographical features. The Arctic coast-line is low and marshy, while the land to the south rises gradually. Low hills rise, in places, from 100 to 200 feet above the surrounding country, but the general aspect of the northern slope is one of flat, unbroken plains, falling off gradually to the shores of Beaufort sea.

To the east of the route between Great Slave and Great Bear lakes, the country is covered with small lakes and aircraft pilots when flying the much travelled route between Rae and Great Bear lake in conditions of poor visibility, simply keep to the western edge of "the country of many small lakes" and are led unfailingly to their destination.

Great Slave Lake to Hudson Bay

Between Rae and Gros Cap, the northeast shore of the north arm of Great Slave lake is fronted by many small rocky islands, while the southwest shore of the arm is more irregular and with fewer islands. At the mouth of Yellowknife river, 79 miles from Rae, is an Indian village.

The more picturesque portion of Great Slave lake is the east arm. From Resolution to Reliance there are three main channels. Hearne channel, which is the one to be described, is 261 miles long from Resolution, and, although more exposed, is the most suitable for steamers. The other two channels are good schooner channels; there is more protection but there are some shoals to be avoided. Both of these latter channels are through very beautiful island scenery. The distances from Resolution to Reliance are: Hornby channel, 261 miles; Inconnu channel, 239 miles. The scenery along the route through the islands in the east arm of Great Slave lake is remarkably beautiful.

The Hearne channel follows the north shore all the way to Reliance. The scenery is rugged and bold. Great precipitous cliffs form the northern edge of many of the large islands and of Pethei peninsula, which is 90 miles long and separates McLeod bay on the north from Christie bay on the south. The cliffs tower to a height of 500 feet above the clear, blue water of the lake and drop off on their south sides in a series of steep pitches to the water. They are formed of many-coloured rocks, and these, with the mosses and lichens clinging to fissures in the rock, add beauty to the scene. If one is fortunate enough to view it with the sun shining on it late in the evening, he sees a picture never to be forgotten.

Eighty-three miles from Gros Cap the route enters and passes through Taltheilei narrows, where Pethei peninsula extends from the southeast shore to within 1,600 feet of the north shore. Through the narrows there is a current, sometimes north and sometimes south, depending upon the wind. The lake now opens out into McLeod bay, along the north shore of which the route continues for 60 miles to Bigstone point, where the course takes a southeasterly direction to the entrance to Charlton bay. Charlton Bay entrance is less than half a mile wide and on Fairchild point, which forms the northerly edge of the entrance, the new Fort Reliance has been located. Here the Royal Canadian Mounted Police have established a detachment and there is a small deep bay which forms an excellent air harbour. Ten miles northeast of this point is the original site of Fort Reliance erected by the Hudson's Bay Company for Captain Back in 1833. The ruins of two old stone chimneys are still in evidence. It is one of the most beautiful sites in Northern Canada. The old fort was built a short distance

from the shore and about 20 feet above the water. The ground is covered with caribou moss and rises in terraces for a considerable distance. The woods are of white spruce, tall and well spaced.

The end of motor boat travel in this direction has now been reached and should one desire to go further, canoes must be used. All routes leading from Reliance to the north or east present great difficulties at the start. Lockhart river, which empties from Artillery lake into Charlton bay at this point, is not navigable owing to the drop of 681 feet in its 25 mile length. The best route over this section is via Pikes portage. The distance to Artillery lake is 24 miles, and ten portages are entailed. The first and longest portage is three and a

Aerial View of Lockhart River

quarter miles long and rises 610 feet to the great interior plateau. Continuing on through Artillery lake, Lockhart river, Ptarmigan lake, and a small lake, the height of land is reached, and the Hudson Bay watershed is here entered. Deville, Smart, and Sifton lakes, and lac du Bois lead to the Hanbury river, down which the journey is made to Thelon river. Fourteen portages are necessary before Thelon river is reached, the longest being two miles around Dickson canyon. Thelon river has no obstructions until that part of the river between Schultz and Baker lakes is reached. On this stretch there are two rapids that would, in low water, prevent the passage of any craft larger than a York boat. Boats having a draught of ten feet or less can be navigated without trouble between the west end of Baker lake and Hudson bay.

From the site of old Fort Reliance to Hudson bay at the mouth of Chesterfield inlet the distance is about 893 miles. The Thelon river forms a good water route through much of this territory. The water is from 3 to 14 feet deep, the course is comparatively regular, and from the junction of Hanbury river to the coast there are only the two obstructions mentioned between Schultz and Baker lakes. The scenery on the Hanbury is remarkable. In speaking of Dickson canyon on Hanbury river, Tyrrell says, "The scenery on this canyon is

by far the wildest and grandest met with on our journey. . . ." After leaving Reliance one does not encounter even outposts of civilization. There are no trading posts until Baker lake is reached. Although there are some groves of spruce along Thelon river and some driftwood after the mouth of Dubawnt river is passed, fuel is very scarce.

THE GREAT INTERIOR PLATEAU

The great interior plateau is the predominant feature of the eastern part of the Mackenzie District and much of the District of Keewatin. An immense tableland, the lakes on its surface having an altitude of from 800 to 1,400 feet, it drops off abruptly on its northern and western boundaries; on the south almost as abruptly just south of the 60th parallel of latitude; and on its eastern side more gradually to the plains on the west side of Hudson bay. Innumerable lakes of all shapes and sizes dot its surface and rivers flow in all directions, generally with comparatively easy gradients in the interior and finally tumbling over its outer edge in a series of steep cascades. The principal rivers are Coppermine and Burnside, the former flowing northward into Coronation gulf and the latter into Bathurst inlet; Back river, with a northeasterly course, emptying into Chantrey inlet; and Thelon with its two tributaries from the south—the Dubawnt and the Kazan—flowing eastward into Chesterfield inlet, Hudson bay.

Eskers—long ridges of sand and gravel radiating from a centre in the vicinity of Dubawnt lake—are seen stretching across the country. They resemble railway embankments, often more than 100 feet above the level of the surrounding terrain. They are the pathways of migrating caribou and form excellent directional guides to travellers, either on foot or in the air. River valleys are almost non-existent in the higher districts of the plateau. From the

Typical View of Country in Vicinity of Upper Dubawnt River

The Dubawnt is seen in the left foreground. The Esker, about 100 feet high, can be traced toward the upper right background. The frost never leaves the ground and as a result there is no well defined drainage.

air the impression is gained of a level field after a downpour of rain—myriads of lakes lying like pools on an undrained surface. Rivers are usually a connected series of spillways between depressions, one of which may be emptying in two or three different directions at one time. So called streams can be followed only by picking out, by close observation, ripples of fast water at "narrows" in what is otherwise one continuous stretch of apparently still water. Toward the eastern edge of the plateau the character of the drainage varies.

The Thelon river, rising far back in the interior, has cut for more than 150 miles along its lower reaches, a very sharply defined channel through sand and sandstone. Flowing through Beverly, Aberdeen, Schultz and Baker lakes, it finally reaches tidal water by way of the deepest indentation in the west coast of Hudson bay—Chesterfield inlet. This inlet, with its continuation Baker lake, forms a navigable arm by which sea-going vessels may penetrate two hundred miles inland. Tyrrell refers to the Thelon river as "one of the finest in Canada, navigable for river steamers and other boats of light draught all the way from Hudson bay to the forks of the Hanbury, a distance of 550 miles, excepting at two rapids above Baker lake where some improvements in the channel may be made." In his judgment the river is probably open five months in the year.

AERIAL VIEW OF CHESTERFIELD
Chesterfield inlet on the west side of Hudson bay, showing Hospital, Church and Hudson's Bay Company Post.

From cape Parry, 300 miles east of the mouth of the Mackenzie river, the country rises abruptly from the seacoast and attains a considerable elevation a few miles inland. The Melville mountains, commencing near Darnley bay, parallel the shore from 20 to 35 miles inland, having an estimated height of from 1,200 to 1,500 feet above sea-level. This range of hills continues to run in a southeasterly direction nearly to the mouth of the Coppermine river in Coronation gulf. Coppermine river has a length of approximately 525 miles. It rises on the height of land north of lac de Gras, and after leaving Point lake it has a deep, wide, strongly marked valley bounded on both sides by high ranges of

rounded hills. Bathurst inlet cuts deeply into the northern shoreline of the mainland. Steep hills, rising sharply from the water, line both sides of the inlet and stand out sharply above surrounding topography. Many natural harbours exist in this sheltered inland sea and deep water features many of its channels.

A little known country lies between Bathurst inlet and the mouth of Back river, but the general character of the terrain is high and plateau-like as is the country west of Bathurst. All that part of the mainland lying north of Chesterfield inlet is of a much more rugged nature than the country to the south, where from Eskimo cape southward the land near the coast is very low lying and the shoreline itself extremely flat and featureless.

Burnside Harbour, Bathurst Inlet
A view showing typical country close to the coast.

Much has been written about the so-called "barren lands" of Canada's Northland. Many travellers and writers who have sojourned in these areas have protested against this appellation, declaring that the term is an entire misnomer and that "Arctic prairies" or "treeless plains" should be substituted in its place. Roughly speaking, the non-timbered portion comprises about one-third of the total area of the mainland of the Northwest Territories and also embraces that of all the Arctic islands. The northern limit of tree growth may be said to follow a line drawn from the mouth of Churchill river at Hudson bay, northwesterly through Nueltin lake, Boyd lake, and Artillery lake. From this point a narrow offshoot or tongue of woods follows the Hanbury and Thelon rivers far easterly into the generally treeless zone. From Artillery lake, the line continues on through the southern end of lake MacKay and south of lac de Gras to Point lake, from there following very closely the course of Coppermine river as far down as the mouth of Kendall river. There turning westerly and passing to the south of Dismal lakes, it parallels Great Bear lake a few miles to the north. At this point it turns northerly to within about 60 miles of the coast, which it follows westerly, gradually approaching the salt water until, in the Mackenzie delta, the distance is only about 10 miles. Continuing westward, the timber line is from 20 to 50 miles inland.

White spruce is the most valuable and also the commonest species of tree found in the Territories. Heavy growth can be seen along the banks of the Slave and Mackenzie rivers. In favoured localities it attains a diameter of over

2 feet and a height of 100 feet. Excellent logs for building and for the manufacture of lumber are utilized at many of the posts along the Mackenzie waterway.

The actual line of demarcation between the wooded and treeless areas is extremely irregular and broken. Isolated groves of trees are found in favourable localities far north of the main forest zone, and along many of the river valleys on their sheltered sides, thin fringes of willows border the streams, giving shelter and cover to ptarmigan and Arctic hare. At no place is a sudden change of vegetation sharply drawn. Stunted spruce trees gradually give way to willows and ground birch and they in turn to still smaller shrubbery and heather growth. On a flight from lac de Gras northward for 150 miles to Bathurst inlet over a high plateau country, no willows or shrub growth of any nature were seen, but on landing at tide-water at Burnside harbour, well within the Arctic circle, a strong growth of willows of good size was observed fringing the banks of the estuary just above high tide level. On climbing a low mountain range south of the post a healthy growth of heather in full bloom was examined at a height of twelve hundred feet above sea-level. In most of the creek bottoms in the treeless areas a rank growth of coarse grass and sedge, often waist-high, covers the flats formed by spring freshets, and in the upland valleys luxuriant meadows afford summer feed for caribou, as do the ground birch and dwarf willows which fringe the water's edge on most of the lakes. Everywhere plant life of some kind is found.

ARCTIC ISLANDS

The greater part of our knowledge of the Arctic islands has been gained from coastal observation, augmented by information obtained from time to time by native hunters and others.

Banks Island

This island, comprising 25,992 square miles, is the most westerly of the larger islands in the Arctic archipelago. On the north it is bounded by M'Clure strait, on the east by Prince of Wales strait, on the south by Amundsen gulf, and on the west by Beaufort sea. It was discovered and named by Capt. W. E. Parry in 1819. In the interior the general elevation is reported to be over 1,000 feet, and the elevation of the southern plateau is stated to be more than 3,000 feet. The coast from cape Kellett at the southwest corner northward to Prince Alfred cape is low and flat. The north coast is higher and more rugged. From its westerly extremity, the land gradually rises as one goes eastward until cliffs reported to be from 1,000 to 1,400 feet high are to be seen rising abruptly from the water in many places between Parker point and Mercy bay. Eastward of Mercy bay the land drops away again to Russell point, which is low at the shore and rises to some 200 feet a short distance inland. Capt. M'Clure reports a hill 600 feet high in the vicinity of Russell point. The east coast is hilly with deep ravines and the land is from 100 to 200 feet high. Nelson head, on the south coast, is a strikingly bold headland 800 to 1,000 feet high, extending some 12 miles west of cape Lambton. From cape Lambton the land becomes lower again until cape Kellett is reached. Stefansson describes Banks island as "a beautiful country of valleys with heather, grass and flowers, except on some bare rock hill tops."

Victoria Island

This island was discovered by Dr. Richardson of Franklin's second expedition, 1825-27. Although this is the third largest of all the Arctic islands, having an area of 79,269 square miles, and lies closer to and within easier access of existing transportation systems, only its western and southern shores have been investigated and little is known of its interior. From the nature of its structure,

which is known to be of limestone, its surface is thought to be fairly level with the greater part having an elevation of less than 500 feet. There are, however, several places where hills are reported to reach an elevation of 1,500 feet. On the northwest coast, hills north of Walker bay and mount Adventure near Armstrong point are reported to be 1,500 feet high. Inland from cape Baring an elevation of 1,000 feet has been recorded.

Commencing at the south side of Prince Albert sound on the west side of the island and about the middle of Wollaston peninsula, there are ranges of hills reported to be 800 feet high. These are probably the Colville mountains. Eastward the land adjacent to the coast appears to be low until the Sussex mountains to the north of Wellington bay are reached. Farther east hills rising to 800 feet are reported north of Cambridge bay. Cape Colborne, south of Cambridge bay, is reported to be high and steep. The remainder of the south coast is low as far as Albert Edward bay on the east coast, where limestone cliffs are reported "high in places." On the east coast near Denmark bay two mountains are reported—Ovidas hill between cape Stang and Greely Haven, and Elsa hill near the east side of Hadley bay. These are the only high spots. The north coast between Glenelg bay and Barnard point is high and precipitous. It is stated to be 800 feet high with stratified rocks at Glenelg bay. The northwest portion is hilly, mostly limestone, and is reported to have many large lakes.

The shoreline of the island is irregular and is deeply indented on the west side by Prince Albert sound, which extends 130 miles inland; Minto inlet, extending 55 miles; and Deans Dundas bay about 15 miles. On the north, Richard Collinson inlet extends inland 55 miles and there are also Glenelg and Hadley bays. Albert Edward bay, extending some 50 miles inland, is near the southeast corner of the island. *The Arctic Pilot,* Volume III, referring to Prince Albert peninsula states "in its interior are ranges of mountains."

There is a trading post at Cambridge Bay on the south coast.

Prince of Wales Island

This island lies between Victoria island and Somerset island and is approximately 14,000 square miles in extent. The coast is generally low. Mount Clarendon of 500 feet elevation in the northwest portion, and Sidney Webb point, also of 500 feet elevation, on the southwest coast are the highest places reported and probably this is the greatest elevation of the island. The only indentations are Baring channel on the north coast, Ommanney bay on the west coast, and Browne bay on the east coast.

Capt. Kennedy of *The Prince Albert* explored the island in 1852. Starting from Kennedy bay on the southeast coast, he proceeded due west. The country hitherto dead flat began to show an occasional elevation but none entitled to the name of a hill with the exception of the solitary peak, mount Washington, to the west of which is an extensive plain. Proceeding westward, the expedition passed through a somewhat hilly tract interspersed by ravines, past the north end of Fisher lake, across the Colquhoun range of hills and on to the extensive tableland. Capt. Kennedy then turned due north over a level country with no lakes nor even rivulets to relieve the monotony, but a conspicuous hill, mount Cowie, was seen to the west. The expedition then continued to Ommanney bay, some 40 miles long, where the level plains give place to a range of high land skirting the north shore of the inlet as far as the eye can see. Turning east, the expedition passed through a hilly tract of country to the shelving shores of Browne bay.

King William Island

This island, comprising approximately 5,000 square miles, lies between Boothia and Adelaide peninsulas and was first visited by Commander J. C. Ross in 1830. In a general way, the southern half of the island is decidedly monotonous in appearance. The land extends back from the shoreline in gradually sloping terraces and ridges of low hills rising to 250 feet. From the reports of natives it would appear that this description applies generally to the northern part of the island. Mount Matheson, a flat-topped hill near the southeast corner of the island, is between 400 and 500 feet high. The land may rise higher further inland but, if so, it is not noticeable. The general character of the terrain is that of grassy, swampy, lake-dotted plains with only occasional stony ridges showing up. The shoreline is irregular and deeply indented with bays and inlets. There is an abundance of vegetation such as heather, dwarf willow, flowers, grass, and some wild berries in the lowlands, whereas the ridges are generally bare. There is a large number of lakes of all sizes. These lakes, except a few more isolated ones in the higher land, contain fish of the kind that find their way to and from the sea. Four fair-sized rivers discharge into the sea on the south side of the island and it is probable that there are others draining the interior into James Ross, Victoria, and Simpson straits. These streams provide fair autumn fishing for the natives, but they do not compare in this respect with the larger mainland streams to the south of the island.

Although King William island does not rank with some other parts of the Arctic and sub-Arctic as a breeding ground for wild birds, yet great numbers and many species of birds breed on the island, including Canada goose, King and common eider duck, old squaw duck, swan, loon, snow bunting, lark, ptarmigan, seagull, tern, owl, hawk, golden plover, a few crane and an occasional raven; also a number of small wading birds.

Foxes are sometimes very numerous. No wolves have been seen recently. Polar bear are common off the west coast but are only rarely found on the south or east sides of the island. Very few caribou have been seen on the island during the past seven years. Before the changes in the migrational routes of the caribou these animals used to cross on the ice from the mainland at the narrowest part of Simpson strait in the spring and recross to the mainland in the fall.

Petersen Bay trading post is the only post on King William island and is located on the southeast coast.

Melville Peninsula

Melville peninsula has an area of approximately 24,156 square miles and is bounded on the east by Foxe basin, on the north by Fury and Hecla strait, on the west by the gulf of Boothia and Committee bay, and on the south by Rae isthmus, Repulse bay, and Frozen strait. It is in the District of Franklin, but is joined to the mainland (Keewatin District) by Rae isthmus. It is some 250 miles from north to south and has a maximum width of about 125 miles. The surface is a more or less uniform plateau some 800 feet high except at its northern end near Fury and Hecla strait where heights up to 1,300 feet have been recorded. The edge of this plateau is from 5 to 25 miles inland. The shore-line is lowest between Parry bay and Hooper inlet on the east coast. Inland valleys are reported to contain much Arctic vegetation. Lyon inlet on the southeast shore is the deepest inlet and Amitioke bay, Hooper inlet, and Richards bay on the east coast, Repulse bay on the south coast, and Lefroy and Garry bays on the west coast form large indentations in the coast-line. There are several fairly good routes across the isthmus from Repulse bay and Lyon inlet to Committee bay.

Boothia Peninsula

Boothia peninsula, discovered by Sir John Ross in 1829, contains an area of approximately 12,960 square miles. It comprises the northernmost tip of the North American continent and is bounded on the north by Bellot strait; on the east by the gulf of Boothia and Prince Regent inlet; on the west by Franklin, Victoria, James Ross and Rae straits, and on the south by Boothia isthmus. Many lakes of various sizes which make the crossing of Boothia isthmus from Lord Mayor bay or Thom bay on the west coast of the gulf of Boothia to Spence bay or Josephine bay on the west side of Boothia peninsula comparatively easy, there being only some five miles of land to be crossed. From Boothia isthmus northward to Bellot strait the distance is approximately 174 miles and the greatest width of the peninsula is about 126 miles. Bellot strait is some twenty miles long and at certain points is narrow—only about one mile wide. On its shores are granite hills to a height of 1,500 feet. Very little information is available regarding the topography of Boothia peninsula. The position of the Magnetic Pole is on the west side of Boothia peninsula and was first determined by Sir James C. Ross in 1831 near cape Adelaide. The adopted position of the Magnetic Pole for 1922 deduced from observations by Roald Amundsen in 1904 is 70° 40′ N, 96° 00′ W.

TRANSPORTATION AND COMMUNICATION

OCEAN TRANSPORTATION

The northern coastal region of the Mackenzie District and the more southerly islands in the west portion of Franklin District are served by the Pacific ocean route, and Keewatin District is reached from both the Pacific and Atlantic. The north coast, including the nearby inhabited islands of the Arctic archipelago, is reached by way of the Pacific ocean, Bering strait, Beaufort sea, and other communicating waters. The eastern portion of Keewatin is approached from the Atlantic by way of Hudson strait and bay.

Until recent years passengers and supplies for the Western Arctic coast were transported by the Hudson's Bay Company from Vancouver via the Pacific route. However, repeatedly bad ice conditions resulting in the loss of several ships brought about the abandonment by the Company of the salt-water route in favour of the route down Mackenzie river. Eastward and westward of the mouth of Mackenzie river a number of small schooners are operated for supplying the Company's posts on the Arctic coast between Herschel island in the west and King William island in the east. The base of operations of these sea-going craft is Tuktoyaktuk, east of the mouth of the Mackenzie, where there is a deep-water harbour.

Captain C. T. Pedersen of the Canalaska Trading Company who began his Arctic whaling and trading business over forty years ago, still brings in his supplies by way of the Pacific. He reports that up to and including 1936 he had made twenty-two trips to Herschel island and never failed to reach that point. Captain Pedersen now uses Herschel island as a trans-shipping base, trade goods for posts extending as far east as southeastern King William island being transferred at that point to smaller vessels. The Canalaska Trading Company does not attempt to furnish transportation service for others along the Western Arctic coast.

The R.M.S. *Nascopie*, a powerful vessel of the icebreaker type, owned and operated by the Hudson's Bay Company, sailing from Montreal, visits Hudson bay each year. For the past four years this vessel has carried the Eastern Arctic Patrol, sent north annually by the Dominion Government, to posts on Hudson bay and strait and on Baffin, Devon, Ellesmere and other islands of the Arctic archipelago. However, transport service along the west coast of Hudson bay is largely handled by the Company in a Diesel-motored schooner of lesser draught than the *Nascopie*.

RIVER TRANSPORTATION

For more than one hundred years the Hudson's Bay Company has been engaged in transportation in the Mackenzie District. Originally the company was concerned only with its own freight, and goods were brought by York boat from York Factory on Hudson bay, up Nelson or Hayes rivers via Norway House and the divide at Portage la Loche whence the journey down the Athabaska to the Mackenzie commenced. To-day the company maintains a fleet of modern steam and motor vessels on the Mackenzie River system which operate on regular schedules during the season of navigation reaching all important points between the end of steel at Waterways in northern Alberta and the shores of the Arctic ocean. The steamboats operated by the Hudson's Bay Company on the Mackenzie route are the flat-bottomed stern-wheel type

which have been found the most suitable for the waters to be navigated. Four of these are maintained—two above the Fort Smith-Fitzgerald portage and two below. They are approximately 150 feet in length and are comfortably fitted out so that the traveller may journey to the Arctic and back, surrounded by reasonable amenities of civilization. Most of the freight is carried in barges which are pushed ahead of the vessels. Several of these barges, which vary in size—the largest carrying three hundred tons—are handled by each vessel.

In addition to freighting on the main Mackenzie River route, the Hudson's Bay Company transports freight along a number of subsidiary routes. These include the following waterways: lake Athabaska, Great Slave lake, up Liard and Fort Nelson rivers, and up Great Bear river to Great Bear lake. Diesel-powered tugs and barges are used for these branch routes, which with the development of mining are becoming of considerable importance and involve the transportation of large quantities of mining equipment and supplies.

The Northern Transportation Company handles a large share of the freight that is moved down and up the Mackenzie River route. This company operates several river, "rapids," and lake power-boats with the necessary scows for the handling of freight from Waterways to Norman and Great Bear lake but does not attempt to compete for the passenger business.

Northern Transportation Early in the Century
Picture taken by J. W. Tyrrell, D.L.S., in 1900 showing survey expedition crossing the Smith portage.

An auxiliary transportation service is necessary between Fitzgerald, Alberta, and Fort Smith, N.W.T., to overcome the rapids of Slave river. A portage road has been in use for many years at this point and the passenger and freight handling equipment has been brought up to modern standards. The amount of freight taken annually over the portage exceeds 5,000 tons. Approximately fourteen miles of the portage road lie within the Province of Alberta and two miles within the Northwest Territories. The Northwest Territories section is maintained by the Dominion whereas the Alberta portion is maintained by Ryan Brothers as one condition of an exclusive commercial freighting franchise which they hold from the Provincial Government of Alberta. Others may use the Alberta section of the road but may not charge tolls for transportation service thereover.

A few years ago Messrs. Corser and Doyle constructed a parallel portage road from Fitzgerald to the Northwest Territories boundary on lands which they hold under lease or permit. At the boundary it joins the Dominion maintained road. This firm also operates a modern fleet of cars, trucks, tractors, etc., for the handling of freight.

From the lower end of the Slave River rapids there is a water route, without serious obstruction, clear to the Mackenzie River delta, a distance of 1,300 miles. In journeying from Mackenzie river to Great Bear lake, St. Charles rapids

on Great Bear river, would have to be surmounted. Freight going into the Great Bear Lake region is trans-shipped four times between Norman and the lake, namely, (1) at the junction of Mackenzie and Bear rivers, (2) below the rapids, about 32 miles upstream, (3) above the rapids, and (4) at the outlet of Great Bear lake. For the past few years freight has been transported over these rapids in shallow-draught, "rapids" boats, but in 1936 a portage road 7½ miles long was completed by the Dominion Department of Public Works, and the Northern Transportation Company commenced taking freight over the road on three-ton trucks. This resulted in the speeding up of the handling of freight which is particularly important in the North in view of the short water-transportation season. The depth of water in Great Bear River rapids averages 16 to 20 inches.

In addition to the construction of the portage road around St. Charles rapids, the Department of Public Works has constructed wharves at various points along the Mackenzie River route and into Great Bear lake to assist in the handling of freight. Other wharves are under construction at the present time.

The Hydrographic and Map Service has investigated navigation conditions in Great Slave lake and in the Mackenzie River Delta area and has issued a number of charts. These hydrographic charts, topographic maps, and other information may be had on application to the Department of Mines and Resources at Ottawa.

Modern Transportation Methods
Eighty-ton boat being hauled across Smith portage by two tractors, 1935.

Aids to navigation are maintained by the Marine Service of the Department of Transport as follows:—

Athabaska River Delta and Lake Athabaska

A. Main channel through Athabaska River delta buoyed with 15-gallon and 45-gallon drums.

B. Flashlight on Calf island, 3½ miles from Chipewyan. This light can be seen from the mouth of the river on the south shore.

Flashlights, stored at Waterways ready to go forward by first boat, will be erected during the 1937 season at the following points:—

1. Gravel island situated at Crackingstone point.
2. Sand point opposite Burntwood island.
3. Mouth of Fishing river.
4. On small island off Maurice point.

Great Slave Lake and Mackenzie River Entrance

Old Steamboat channel: 5 flag buoys, 2 barrel buoys, 2 land markers (flags on poles mounted on tripods).

East channel: 4 flag buoys, 8 barrel buoys, 7 land markers (flags on poles mounted on tripods).

Resolution: 1 flashing lantern.

Burnt island: 1 flashing lantern.

Buffalo river: 1 flashing lantern.

Hay River: 2 coal oil range lights, 2 flag buoys, 1 flashing lantern.

Mackenzie river entrance: 1 spar buoy, 1 barrel buoy, 2 coal oil range lights.

Range island: 4 barrel buoys.

Outpost islands: 1 flashing lantern, 1 barrel buoy.

Rae: 20 barrel buoys.

The flag buoys are not exactly buoys but are black and white flags on masts nailed to poles driven into the mud. These were found to be superior to barrel buoys and were used wherever it was possible to drive poles into the river or lake bottom. They can be seen much farther than the barrel buoys as they stand eight to ten feet above the water.

The improvements to be carried out during 1937 are: 1 flashlight to be erected at the entrance of Yellowknife river; the entrance to Frank channel from Rae to be marked with large day beacons; and the channel to Rae to be buoyed.

Great Bear Lake

Two coal-oil lamps have been in operation for the past two seasons: one at the point where the lake empties into Great Bear river and one at LaBine point.

Two lights, complete with gas accumulators, are stored at Eldorado and instructions have been issued that they be placed in July, 1937. One is to be located at Leith point and the other on one of the Five Sisters islands. These islands lie about 60 miles east of Fort Franklin.

NAVIGATION CONDITIONS

It would be quite beyond the scope of this report to publish anything in the nature of sailing directions. However, it is felt that general information relating to navigation conditions might be of interest, particularly that of recent origin which might supplement to some degree what is already available in books of reference, i.e. reports of exploratory expeditions, narratives of whalers, *The Arctic Pilot*, etc.

The navigation season along the Hudson Bay coast is to all intents and purposes that of the Hudson Bay route. In this connection the Hydrographic and Map Service in its publication "Sailing Directions for the Hudson Bay Route," as amended, states: "Period of Navigation: The period of open navigation in Hudson strait and bay varies somewhat from year to year, but in general may be considered to extend over the months of August, September and October. Churchill harbour, however, is liable to close with ice about the middle of October."

As for the navigation season along the Western Arctic coast Captain Pedersen, referred to earlier, reports:—"It is impossible to figure on reaching point Barrow or Herschel island on any fixed date. The earliest date that I was able to get around point Barrow was July 13 and the latest date was August 26. For Herschel island, the earliest date was July 26 and the latest date I was able to work through the ice to Herschel island was September 1. The winds have all the say about the ice conditions on the Arctic coast. A moderate gale of wind from the northeast will clear the whole Western Arctic coast of ice in two or three days, whereas a westerly wind will hold the main ice pack hard up against the land and make it impossible for a vessel to work through.... In 1931 when the *Baychimo* failed to get out and was carried away by the ice-pack during the winter, we had nothing but westerly winds that held the pack tight against the land and our vessel and the *Baychimo* could not get around point Barrow until August 21. The pack was already frozen together east of Barrow, but we had a little northeast wind which cracked up the ice some along the coast, and we arrived at Herschel on August 26. We left Herschel for home on September 5 after working night and day to unload our cargo of supplies and also two 50-foot power schooners that we carried on the deck of the *Patterson* for some Eskimos. I knew that it would be a hard time for us to get out and I hardly ever came out of the crow's-nest, night or day for four days, until we got out of the ice a little to the southward of Icy cape. When we stopped at Wainwright to pick up the mail, the ice looked impassable, and the old trader at this place predicted that we would have to winter near there, as we would never get around Icy cape. However, the ice conditions had been just as bad all the way from Herschel, so I just laughed at the trader, and said we are simply going to work through to open water. He wrote me during the winter that the ice pack had shoved up on the beach just 9 hours after we left Wainwright, and never slacked up again that fall.... Under normal ice conditions a vessel can make the round trip to Cambridge Bay without any danger of being frozen in for the winter."

The Fur Trade Commissioner of the Hudson's Bay Company forwarded a statement from which the following is extracted:—

"Vessels visiting the Western Arctic via the Bering Sea route should aim to reach point Barrow on approximately July 20 as experience has shown this is about the earliest date when the polar ice will permit rounding this point. The first opportunity to pass may not occur for a month later but ships should be there to take earliest advantage of it. Outward-bound vessels should aim to pass point Barrow not later than September 10 in order to avoid being frozen in for the winter, in fact, September 1 would be a safer date. The date on which Canadian Arctic waters are reached and the speed of the vessel will indicate how far east the ship may safely penetrate. From 1925 to 1930 inclusive the Hudson's Bay Company's ss. *Baychimo* was able to reach Cambridge Bay from Vancouver and return the same season. In 1931 this vessel was unable to reach the outside (the Pacific ocean) after proceeding only as far east as Coppermine, in Coronation gulf, and she was ultimately caught in the ice and lost just south of point Barrow. Under exceptionally favourable circumstances a vessel might possibly reach Peterson bay, King William island, from outside and return the same season, depending on her speed and the number of calls necessary en route.

"Normally navigation is possible around point Barrow from about July 20 until September 10 but from 150 miles southward of point Barrow to Herschel island the coast is exposed to the polar pack all the year round and the extent to which the intervening coast is clear during the period mentioned depends on the winds. Unfavourable winds can block it entirely for most of the summer. Usually once point Barrow is passed eastbound, Herschel island may be reached without much difficulty but not always, while eastward of Herschel island navigation becomes easier, and once Baillie island is passed little further ice is encountered until Queen Maud gulf is reached. Coronation gulf is usually free

of ice from mid-July until early October. Queen Maud gulf is normally navigable from early August until mid-September, but old ice may be encountered here all summer.

"In a normal season one might expect to reach Cambridge Bay and get out the same year. Under very favourable conditions one might even reach Peterson Bay and still get out, while at the other extreme it might be possible to penetrate only as far as Herschel island. The winds prevailing during the summer govern the ice conditions which in turn control the extent of navigation."

A post manager of the Hudson's Bay Company who had spent several years on King William island stated that there is about seven weeks open water at Peterson bay, commencing about the second week in August.

The Royal Canadian Mounted Police has had a floating detachment stationed in the Western Arctic for the past few years on board the schooner *St. Roch,* which was specially constructed for police work in that area. This detachment winters at various points along the coast and by reason of its mobility is able to keep in touch with a very large territory. The following excerpts from a report covering the voyage of this schooner from Esquimalt, B.C., where it had been undergoing repairs, to Cambridge Bay, N.W.T., is of interest in connection with navigation problems in the Arctic waters traversed.

"On June 25, 1935, the *St. Roch* left Esquimalt for Herschel, Yukon Territory. Bering sea was reached at 7 p.m. July 7, and the vessel arrived at Dutch Harbour at 5.45 a.m. July 8. The voyage from Vancouver to Dutch Harbour is a distance of 1,685 miles, and was made in 11 days, 16 hours. Very strong head winds were encountered during this portion of the voyage. Dutch Harbour was left on July 10, and the *St. Roch* passed through Bering strait at 6 p.m. July 14, and arrived at point Barrow at 4 p.m. July 17, where the M.S. *Patterson* of the Canalaska Trading Company was at anchorage. Very heavy ice was in view to the east.

"From this point on the vessels continually 'worked ice,' being held at times for several days. During the passage through the ice, it is necessary to navigate the vessel as close to the shore as possible, the ice being thin and more rotted than is the case with the ice at a distance from shore. Large expanses of unbroken ice covered with mud and dirt deposited by the winter winds made it difficult for the vessel. Sometimes the vessel scraped bottom in efforts to get into open leads.

"In Smith bay the ship was caught by heavy ice pressure, which gave her a considerable list to port, and it was so held for 20 hours. Prior to this the ship had been moved ahead, in order to get a large piece of ice under the stern to act as a buffer.

"Cape Halkit was passed on June 25, and Beechey point was reached on July 27. After leaving Beechey point, strong currents were encountered. The larger ice floes drifted to the west, whilst the small ones drifted towards the east. This made navigation extremely difficult, as it caused open leads to suddenly close, necessitating a quick change in course.

"At one point the vessel was stuck between two grounded ice floes, and it was impossible to use the propeller or rudder. The vessel was finally released by using an ice anchor, and forcing the bow around by using the anchor windlass.

"Owing to heavy ice to seaward, the vessel proceeded inside the Midway islands. This passage is seldom used, except in cases of emergency, on account of the changing depths caused by ice pressure. Soundings were taken every two or three minutes, and flat bottom was found between three and one-half, and four fathoms. The bottom was composed of soft silt or mud.

"On July 28 the vessel grounded in eleven feet of water. Immediately prior to grounding, four fathoms of water was sounded. Within six hours the strong currents had washed the silt away from the keel, permitting the ship to float over the bar, only to ground almost immediately. By noon of the 28th the

bottom again changed, and the vessel floated in two fathoms of water. A course was marked by means of small buoys of wood. No other bars were located and by 2 p.m. the soundings averaged around five and six fathoms. The *St. Roch* continued on its course, proceeding outside a chain of small islands that extend as far as Flaxman island. Good time was made despite the many scattered ice floes.

"Barter island was reached early on July 29, and the heaviest ice so far seen was at this point. Course was taken around the east end of the island, where the *St. Roch* was nearly forced ashore by the ice pressure from seaward. Being unable to turn and retrace its course the *St. Roch* proceeded on eastward and passed Barter island. Floes were encountered, some of which were 25 to 30 feet in height. It is understood that these floes were exceptionally large for that part of the coast, so close to shore. Fairly good time was made until Humphey point was reached at 5 p.m., but it was not possible to proceed further until 5 p.m., July 30, when the ice loosened sufficiently to allow the *St. Roch* to force its way through to Demarcation point, which was reached at midnight, July 31.

"From Demarcation point, ten days were occupied in the voyage to Herschel island, a distance of only fifty miles. This delay was caused through a strong southwesterly wind, forcing the bay full of heavy ice-floes. Herschel island was reached at 11.30 a.m., August 10. The *St. Roch* left that point on August 14 for the east and encountered heavy ice very shortly after sailing. Poor progress was made until Pullen island was reached, where the water was free of ice. No further ice conditions were encountered for the remainder of the open-water season. Cambridge Bay was reached on September 13, and arrangements were at once made to prepare the vessel for the winter. The inner bay froze over on September 20, and on September 28 the vessel moved into the ice, and was frozen fast by October 1 in the desired position for the winter.

"It was noted that the freeze-up at Cambridge Bay was three weeks earlier than at Tree River, consequently cutting down the cruising time of the vessel to a considerable extent."

The following from another report submitted by the *St. Roch* detachment gives information regarding the navigation season in the Cambridge Bay-Tree River area:—

"If the *St. Roch* were to winter at Cambridge Bay she would probably be able to leave there between July 20 and 25 in an average year, but in a later break-up it would be considerably later. From information gathered I understand that one cannot leave very much earlier than July 25, at any time. The reason for this is that Dease strait and Coronation gulf being so narrow, and full of islands, there is never much movement to break up the ice, and one practically has to wait until the ice is rotten enough to break through. In former years when wintering at Tree River we have always managed to arrive at Herschel island from a week to ten days earlier than the Canalaska ship *Nigalik* which winters at Cambridge Bay.

"In comparison with wintering at Tree River, I do not think the delay occasioned by the later start would interfere with the *St. Roch* being able to return to Cambridge Bay, providing that only the round trip is made, and that nothing unusual or unexpected occurs to cause delay. The freeze-up may start at any time after the first of October in the harbour, but one should be able to get in up to the 10th in an average year. A low-powered vessel should not steam around after the 10th as it would be very difficult to get in any harbour after the ice forms."

Mackenzie Delta

The following extract from a report furnished by the Hydrographic and Map Service on the Mackenzie route supplies more detailed information in regard to navigation through the delta:—

"The main river from point Separation is navigable to the sea and provides also an alternative route to Aklavik, via Aklavik channel.

"At Aklavik, the Peel, Aklavik, and several smaller channels are united in the West channel. Traffic to Shingle point, Herschel island, and points west, follows this channel northward 44 miles to its junction with Anderton channel, or, better, 52 miles to a point indicated on the map by a permanent monument (P.M. 0170). Here one may turn west into a channel which joins the Anderton or east into a smaller channel now known as Riddle channel. Anderton channel has many bars in it and a wide shallow mouth through which 5 feet could be carried only with difficulty, in 1930. Riddle channel is clear throughout with 9 to 18 feet of water. The depth of water was 6 to 7 feet at its mouth in 1930.

"Referring now to Hydrographic and Map Service print of Mackenzie bay it will be noted that, with the exception of a deep trough 1½ miles offshore, extending from abreast of the mouth of Riddle channel to midway to Tent island, the bottom of Mackenzie bay is very even and not more than 6 feet can be counted on at low tide to well beyond Tent island. The broad channel into which the Riddle and Anderton channels and many others empty, apparently carries the greater part of the Mackenzie River discharge and there is a strong current along the coast from the eastward. North-northeast across the broad channel, a distance of 7 miles, is the western entrance of a well defined channel across the delta, that leads to Tununuk.

"The best water is clearly indicated on the print and this channel, in conjunction with the West and Riddle channels, offers the best route from Aklavik to Tununuk. The objections to its use are the 7 mile run in open water across the broad channel and the strong contrary current as far as the junction with the Middle channel of the Mackenzie, about 6 miles west of Tununuk.

"Most of the traffic to Kittigazuit, Tuktoyaktuk and coast points east of the Mackenzie delta, moves via Aklavik channel to its junction with the Middle channel of the Mackenzie, down this as far as Oniak channel, then through the Oniak and into the East channel of the Mackenzie. There are so many intersecting channels on this route that the use of a pilot is highly advisable.

"At Tununuk, a small unmistakable island shaped like a flattened cone, the East channel splits in two. The eastern branch widens gradually until it debouches into Kugmallit bay through low islands of delta formation abreast of Kittigazuit. The western branch follows the western shore of Richards island for a distance of fully 30 miles and has good depth. As the branch swings left, away from Richards island, it breaks up into a number of broad, shallower streams which flow between low, flat, grass-covered islands on which waterfowl nest in great numbers. Over and beyond these flats may be seen the islands of the Kendall, Garry, Pelly group, with elevations of 100 feet and more. The islands are reached by approach through the most direct channel and a course is steered between Kendall and Whale islands. A permanent camp, the only one in many miles, has been established by an Eskimo Anuktuk (christened Dennis) on the northwest shore of a cove in Kendall island. Although the islands have steep banks and rise in parts to considerable height, depths of only 6 to 8 feet were found in the channels between them, and numerous drying bars were found within the confines of the island group."

AIR TRANSPORTATION

Although aircraft were only introduced into the Northwest Territories sixteen years ago, they were so admirably adapted to the requirements of the Canadian North that the development of air transport service in the western portion of the Northwest Territories has been extremely rapid. To-day almost any part of the mainland of Northern Canada, and many of the Arctic islands, can be reached in two or three days from the end of steel. Unfortunately figures available as to the mileage flown and merchandise handled by the commercial

concerns operating in that area cover both the western Northwest Territories and northern Alberta and northern Saskatchewan. However, the figures for the Territories are very large.

Commercial companies operated numerous aircraft of different types for the carrying of passengers and freight and their records have been extremely good. By the co-operation of the Royal Canadian Air Force with the Department of Mines and Resources extensive areas in the Northwest Territories have been photographed from the air during the past few years—a much greater area than would have been possible to survey had it been necessary to depend on ground survey methods. The opening up of new mining districts has been facilitated, not only by the availability of aerial survey maps but also by the information gleaned by experienced officials from the aerial photographs themselves.

Aerial Transportation
Dominion Land Surveyor and his equipment being landed on the upper Yellowknife river.

Each spring and fall the air transportation service to Northern Canada is interrupted by break-up and freeze-up. Each of these interruptions last about one month, spring break-up beginning roughly around the middle of April and fall freeze-up during the latter part of October.

During the summer of 1935 an officer of the Department of Transport made a tour of the Mackenzie River and Great Bear Lake sections of the Northwest Territories, and of Yukon Territory, in the course of which detailed reports of routes and landing facilities were prepared and recommendations for improvements made. On the technical advice furnished by this officer seaplane bases and winter landing facilities at the most important points in the Territories have been improved by the Department of Mines and Resources.

AIR MAIL SERVICE

From Edmonton and McMurray down the historic Athabaska, Slave, and Mackenzie River waterway, to Aklavik, and to Herschel island, Yukon Territory, and Chesterfield inlet, on the west coast of Hudson bay, mail is now conveyed in a matter of hours and days instead of weeks and months. The mail planes operate on regular schedules with varying frequency, carrying letters, papers and parcels to the widely scattered traders, trappers, prospectors, miners, mission

workers and Government officers inhabiting this vast area. Illustrative of the extent of this service is the schedule which calls for eighty trips to serve Fort Smith; forty trips to Resolution; twelve to Hay River, Providence, Simpson, Wrigley, and Norman; six trips to Good Hope, Arctic Red River, McPherson, and Aklavik; and a regular monthly trip to Cameron Bay and Rae. Mail goes in much more frequently than this, however, as special commercial flights are often used to give the inhabitants more frequent service; Royal Canadian Mounted Police patrols are utilized, particularly to Herschel island and to Chesterfield inlet and other out-of-the-way points; but the above indicates the definite contractual obligation of the air operators.

After some experimental mail-carrying flights which demonstrated the entire feasibility of the operation from a postal service point of view, the Mackenzie River Air Mail Service was officially inaugurated on December 10, 1929. Prior to that time dog-teams had been the sole means of transport in the winter months, and the volume of mail was accordingly small, and limited to letters and papers. A striking change came with the provision of regular air mail facilities. Five tons of mail were carried on the inaugural flights. Over one thousand pounds of this was for Aklavik alone, as compared with less than two hundred pounds for the whole of the previous winter, the latter laboriously and slowly carried in by dog-team. This air service was carried out with speed, precision, and comparative ease.

Postage rates, an important consideration with the inhabitants, have been kept down to the lowest possible figure. There is no surcharge for air conveyance of letters. Newspapers and printed matter generally are carried at letter rate, and parcels are subject to a somewhat higher rate than those carried by ordinary means of transport. Nearly sixty thousand pounds of mail are carried every year on the route between McMurray and Aklavik alone.

WIRELESS SERVICE

Wireless service in the Northwest Territories has kept pace with civil aviation and the air mail service, and there has been developed a network of wireless stations that meets in a fair way the present needs of the Territories. The stations are operated by the Dominion Departments of National Defence and Transport, and by private corporations. The private corporations, although operating their equipment for their own purposes, nevertheless supplement the service to the public provided by the Government.

The Department of National Defence operates a chain of radio stations extending from Edmonton, Alberta, to Herschel island, in the Western Arctic. This system is manned by personnel of the Royal Canadian Corps of Signals. The stations were originally established to provide wireless telegraphic communication facilities between Edmonton and the larger isolated communities of the North. Additions to the system have been made from time to time as development of the country took place. There are now ten stations within the Northwest and Yukon Territories and four connecting stations in Saskatchewan and Alberta.

Traffic is exchanged with the Department of Transport radio station at Coppermine, N.W.T., via Cameron Bay and with connecting land lines as follows:—

Canadian National Telegraphs—Edmonton, Alberta.

Canadian Pacific Telegraphs—Edmonton, Alberta.

Government Telegraph Service—Edmonton, McMurray, and Dawson.

Information on tariff rates is available at all telegraph offices.

In addition to the original function of the system in providing point to point communication by radiotelegraphy, most of the stations are now equipped with radiotelephony for communication with aircraft and with other low-powered

short-range stations. The normal point to point service is carried out on 200 kc/s., and alternative frequencies of 193 and 207 kc/s. may be used. Watch is maintained on 4355 kc/s. for aircraft and alternative frequencies may be used as required. The hours of watch are not continuous and aircraft wishing to communicate with stations of the system should advise the Traffic Superintendent, Northwest Territories and Yukon Radio System at Edmonton of their proposed movements and route.

A daily News Bulletin prepared under the direction of the Minister of Mines and Resources is transmitted from Edmonton to all stations in the Mackenzie District.

ROYAL CANADIAN SIGNALS RADIO STATIONS—N.W.T.

—	Call Sign	Normal Freq. Kc/s.	Ant. Watts	Type Emission	Lat. N.	Long. W.
					° ′	° ′
*Herschel Island	VEE	200	100	A_1	69 35	138 55
*Tuktoyaktuk	VEK	4865	10	A_1	69 30	133 10
Aklavik	VEF	200	250	A_1	68 15	135 0
		4355	250	A_1		
Norman	VEX	200	1000	A_1	64 55	125 35
		4355	400	A_1 A_3		
Cameron Bay	VEN	200	100	A_1	66 5	117 55
		4355	75	A_1 A_3		
Simpson	VEC	200	250	A_1	61 50	121 20
		4355	250	A_1		
†Rae	VEM	200	100	A_1	62 50	116 5
		4355	75	A_1 A_3		
Outpost Island	VEP	4355	10	A_1 A_3	61 40	113 35
Resolution	VEH	200	100	A_1	61 10	113 40
		4355	75	A_1 A_3		
Fort Smith	VEG	200	1000	A_1	60 0	111 55
		4355	400	A_1 A_3		
Chipewyan	VET	200	100	A_1	58 45	111 10
		4355	75	A_1 A_3		
McMurray	VES	200	1000	A_1	56 45	111 25
		4355	400	A_1 A_3		
Goldfields	VEO	4355	25	A_1 A_3	59 25	108 30
Edmonton	VED	200	1000	A_1	53 35	113 30

*Summer Operation Only.

†This station is to be transferred during the summer of 1937 to Yellowknife.

A_1—Continuous Wave Telegraphy.

A_3—Radiotelephone.

The Radio Branch of the Department of Transport maintains two wireless stations in the western portion of the Northwest Territories, as follows:—

Chesterfield Inlet—(Combined Coast and Direction Finding Station)

Position.—Lat. 63° 20′ 05″ N., Long. 90° 42′ 33″ W.

Call Sign.—VBZ.

Calling Frequency.—500 kc/s (600 metres). D.F. bearings are given on 375 kc/s (800 M.) after contact has been made on 500 kc/s.

Hours of Service.—Continuous during the season of navigation. No fixed hours during the remainder of the year.

General.—Contact between this station and Ottawa headquarters is maintained by short wave, through the Ottawa Station, VAA, and Port Churchill Station, VAP, of the Department of Transport.

On Tuesdays and Fridays at 10 p.m., E.S.T., this station broadcasts by voice on 555 kc/s (540·5 metres) information consisting of press news and personal messages, for the benefit of traders, settlers, miners, missionaries, and others within range.

Coppermine—(Coast Station)

Position.—Lat. 67° 47′ 00″ N., Long. 115° 15′ 00″ W.

Call Sign.—VBK.

Calling Frequency.—500 kc/s (600 metres).

Hours of Service.—No fixed hours. Open throughout the year.

General.—Contact between this station and Ottawa Headquarters is maintained by short wave through the Ottawa Station, VAA, and Port Churchill Station, VAP, of the Department of Transport.

On Wednesday and Saturday at 11.05 p.m., E.S.T., this station broadcasts by voice on 571 kc/s (525 metres) information consisting of press news and personal messages for the benefit of traders, settlers, miners, missionaries, and others within range.

Regular weather observations are taken and forwarded twice daily by the larger stations to the Meteorological Service of Canada at Toronto, Ontario. All stations provide weather information free of charge to any point of the system as an aid to aerial and marine navigation.

For the past few years during each fall-to-spring season the Canadian Broadcasting Corporation has set aside a period each week, known as the "Northern Messenger," for the broadcasting of personal messages to persons stationed in northern Canada at points distant from land telegraph lines. The reception is reported to be good and the messages are much appreciated by the recipients.

CLIMATE AND WEATHER OF THE ARCTIC*

There is a marked distinction between the climates of the eastern and western Arctic regions of Canada. This distinction is most clearly manifest in July. Along the Arctic Circle the average temperature of July ranges from about 42° F. in southern Baffin island to about 60° F. in the lower Mackenzie valley and the northern portion of Yukon Territory. On the lower portion of Ellesmere island the average temperature is less than 40° F. and this mean temperature obtains throughout the Parry islands. If we take the isotherm of 10° C. or 50° F. in July as the criterion of a northern summer, we find that there is no summer north and east of a line which begins on the Labrador coast, touches the southern end of Ungava bay and passes across Hudson bay from the Belcher islands to Eskimo point, thence northwestward to the mouth of the Coppermine and along the Arctic coast to the mouth of the Mackenzie.

In midwinter all the Arctic territory is subject to periods of great cold and these periods are associated with the slow outflow of probably shallow but extremely dry and cold domes of surface air from the region west of the Parry islands and Victoria island. These masses move in midwinter up the Mackenzie valley to spread out over the Canadian prairies before showing much tendency to drift eastward. As the year advances, the eastward component of motion becomes much more important than the southward component so that in midsummer the eastern Arctic continues to be dominated by wintry conditions, while the western Arctic is increasingly influenced by air masses modified over Alaska and the north Pacific ocean. In fact, air masses which have been recently modified in more southerly latitudes of the continent frequently affect the weather of the western Arctic. As a consequence, the mean annual highest temperature in Baffin island is about 65° F. whereas on the Arctic Circle in Yukon it is 85° F. or higher.

There is some compensation in midwinter since the eastern Arctic is influenced to some extent by polar Atlantic air masses which bring periods of comparatively mild weather to at least Baffin island and the Hudson Bay area. The extreme lowest temperature of the year is on the average −30° F. to −40° F. in southern Baffin island and −55° F. to −60° F. in the Mackenzie valley. There is, therefore, considerably greater loss of heat by radiational cooling at the surface in the western Arctic.

These seasonal differences have one important consequence in that limited agriculture is possible in the Mackenzie valley on the Arctic Circle, whereas the corresponding latitude of the eastern Arctic is only tundra.

The annual precipitation of the Canadian Arctic is at a maximum on the southeastern coast of Baffin island where it averages twenty inches or more. Inside the mountainous coast of the eastern Arctic and northward from Southampton island through the archipelago the amount probably averages less than ten inches. In the Mackenzie valley and Yukon Territory and probably on the western portion of Victoria island and Banks island the annual amount is between ten and twenty inches. In this connection it may be of interest to note that on the western portion of the North American continent but east of the Cordilleran area there is a distinct tendency towards the peak of precipitation between March and September. This is first in evidence in March in the western portion of the region bordering the gulf of Mexico and it advances northward through the Great Plains of the United States, appearing in June in

* By A. J. Connor, Meteorological Service of Canada, Department of Transport.

southern Saskatchewan; in July in the northern portion of the western grain region; and, finally, in late August or September in the western Arctic. This advance is associated with the invasion of northern latitudes by warmer air following upon the strong heating at the surface. The late date in the far northwest generally coincides with the increased activity of outflows of cold air masses from the region of Beaufort sea. Therefore, the annual peak of precipitation in the Mackenzie valley involves both rain and snow.

From this very brief outline of the most striking characteristics of the Arctic climate we may pass to a consideration of the weather of the last few years in more detail. In the "Monthly Record of Meteorological Observations," published by the Meteorological Service of the Department of Transport, Canada, there are convenient tables such as those on page 35 of the number for January, 1936, which compare the observations of pressure, temperature, humidity, cloud, visibility, and wind at selected stations in Canada, including those of the Yukon and Northwest Territories. A summary of these has been condensed in the accompanying table.

A survey of the table of temperature and precipitation will disclose first of all that the temperature régime at Resolution island differs very considerably from that at all other stations listed. Its position, a small island outside the entrance to Hudson strait, gives it an essentially Arctic-maritime climate. The mean temperature of the coldest month, barely five degrees below zero, is ten degrees warmer than that of Lake Harbour within the strait. For a similar reason the mean temperature of August, the warmest month, at Resolution island is lower even than that of Pond Inlet and Craig Harbour much farther up the east coast. Its annual periodic range, that is, the difference between the temperatures of the warmest and coldest months, is 44·4 degrees which is much the smallest of all the stations listed. Omitting Resolution island, we have an average periodic range for the eastern Arctic of 69 degrees and for the western Arctic, 78 degrees. It will be noted that Nottingham and Lake Harbour in Hudson strait have a lower periodic range, about 60 degrees, than stations on Hudson bay or on Baffin island. The greatest periodic range is to be found near the Arctic Circle in Yukon Territory and the Mackenzie valley, 80 to 82 degrees. The distinction already noted between the temperatures of the warmest month in the eastern and western Arctic respectively is quite evident in the table. The values for the extreme highest and extreme lowest temperatures are listed only for the warmest and coldest months. An occasional cold spell of great severity in some other months may produce an even lower temperature than that listed as, for instance, at Good Hope in December, 1910, when a temperature of —79° occurred.

At some of these stations the record covers a very short period and the values given will probably be changed to some extent, particularly the extreme values, as the period of record increases. The same will be true also of the precipitation records which in the case of the eastern Arctic are especially to be treated with reserve. The difficulties of measuring snowfall in a region where the snow is often driven so as to leave bare ground except in gullies, are well-known. Probably the normal total of 11 inches at Nottingham island is a little low. However, this cannot be definitely stated. The occurrence of the maximum precipitation in October at Craig Harbour may also be peculiar owing to the short record.

The daily range of temperature allows the user of the table to easily derive the mean daily maximum and the mean daily minimum. If half the daily range is added to the mean temperature, one obtains the mean daily maximum. Subtracting half the daily range will give the mean daily minimum. It should be noted, however, that the mean daily range in all months, but especially in the winter, is not so much due to a diurnal periodicity of temperature as to successive warming and cooling due to the onset or passage of cold or warm air masses. During the Polar Year when observations were made hourly at Cape

Hopes Advance on Hudson strait there is some evidence of a diurnal period even in January. The coldest hour in January, 1933, was 9 h. and the warmest hour 17 h. with a difference of 2·8 degrees. In July and August of that year the continuous records showed the coldest hour at 3 h. and 5 h. respectively and the warmest hour at 15 h. with a difference of 5·4° F. and 2·7° F. respectively. Since these are much smaller figures than the daily ranges given for the nearby stations at Lake Harbour and Nottingham, one may appreciate the much greater magnitude of the temperature changes due to movements of air masses rather than to changes in local heating throughout the day.

Observations of cloudiness fall most frequently either in the class "clear to 20 per cent cloudy" or in the class "80 to 100 per cent cloudy" in January. This is perhaps to be expected since the air associated with periods of great cold is naturally dry and clear and only when a frontal discontinuity is established between such an air mass and one of warmer characteristics will much cloud be expected. The cloudiness associated with frontal discontinuities is generally, of course, in the class of "80 to 100 per cent." In July this arrangement of cloud frequencies is not so prominent, particularly in the western Arctic but remains considerably in evidence along the coast of Baffin island.

Observations of visibility are available from a few stations in recent years and exhibit a number of peculiarities, some of which are no doubt due to the judgment of the observer. In the winter months in the Arctic, on account of a long period of darkness, it is probably difficult to lay down a rule for the determinations of visibility which will be uniformly followed by all observers. At Aklavik, for instance, in January at the morning observation the visibility is uniformly very low while at the evening observation two-thirds of the observations show poor visibility and one-third poor to moderate while good visibility seems never to be recorded. At most other stations the conditions are reversed with more than one-third of the observations indicating good visibility and the remainder poor to moderate. In midsummer good visibility is indicated about two-thirds of the time with most stations showing a distinct improvement in visibility at the evening observation over that at the morning observation.

In January most observations of wind-force fall in the classes "calm" or "force 1 to force 3." Chesterfield and Resolution island appear to have a fairly large percentage of winds in class "4 to 7." In the western Arctic the prevailing winds are either north and northwest or west and southwest while in the eastern Arctic north and northeast or south winds dominate in January. This is a rather sweeping generalization from which, of course, there is considerable deviation in some years. In the summer months in the western Arctic southerly winds are increasingly frequent and easterly winds in the eastern Arctic.

The observations of humidity are very difficult to obtain in the Arctic regions by means of dry and wet thermometers. After a film of ice has formed upon the wet bulb few observers are able to read the depression of the temperature with any accuracy owing to evaporation. At the very low temperatures obtaining in the winter months an extremely small amount of moisture is necessary for saturation. Therefore, the few observations which we have and which indicate an average relative humidity between 70 and 85 per cent may not be far from the truth. In midsummer an average relative humidity of 65 to 70 per cent at the evening observation and of 80 to 85 per cent at the morning observation may be approximately correct. On the coast of Baffin island, however, the relative humidity appears to be quite high both morning and evening. During the year of polar observations careful note of relative humidity for each hour at Cape Hopes Advance in January, 1933, showed an average of 87 per cent with a range of 2 per cent between the maximum at 9 h. and the minimum at 15 h. In July there was a range of 10 per cent between 87 at 5 h. and 77 at 14 h., the month averaging 82 per cent.

To sum up briefly, the eastern Arctic possesses a distinctly polar-maritime climate while that of the western Arctic is better described as polar-continental.

—	Temperature, F. Coldest Month				Temperature, F. Warmest Month				Annual	Precipitation (in inches)				
	Mean	Daily Range	Extreme Highest on Record	Extreme Lowest on Record	Mean	Daily Range	Extreme Highest on Record	Extreme Lowest on Record	Periodic Range	Annual Rainfall	Annual Snowfall	Total Annual	Total Driest Month	Total Wettest Month
WESTERN ARCTIC														
Aklavik	−18·9 Jan.	16·9	44	−56	55·0 July	18·6	93	30	73·9	4·95	59·3	10·88	0·41 Dec.	1·78 Aug.
Dawson	−22·4 "	13·0	30	−68	59·3 "	26·0	95	29	81·7	6·77	56·4	12·41	0·49 Mar.	1·58 Aug.
Good Hope	−22·9 "	20·0	42	−69	59·5 "	25·7	95	28	82·4	5·13	51·2	10·25	0·47 Jan.	1·63 Aug.
Norman	−18·6 "	14·6	37	−62	59·2 "	24·5	92	27	77·8	7·02	36·8	10·70	0·36 Nov.	1·94 Aug.
Simpson	−19·2 "	16·4	39	−62	61·6 "	23·3	94	31	80·8	7·67	57·8	13·45	0·49 Mar.	1·78 July
Fort Smith	−15·1 "	16·1	40	−64	59·9 "	26·7	92	24	75·0	8·55	41·2	12·67	0·39 Mar.	2·00 July
Coppermine	−21·5 Feb.	11·5	14	−53	50·8 "	16·4	84	33	72·3	4·97	62·9	11·26	0·32 Jan.	1·50 Aug.
EASTERN ARCTIC														
Chesterfield	−26·6 Jan.	13·1	30	−55	48·0 July	17·0	84	26	74·6	7·96	43·3	12·29	0·15 Jan.	2·18 July
Churchill	−18·9 "	16·1	32	−57	52·9 "	22·6	96	22	72·8	10·02	68·2	16·84	0·62 Jan.	2·60 Sept.
Nottingham	−17·0 Feb.	11·9	21	−42	43·0 Aug.	12·0	64	29	60·0	5·09	59·0	10·99	0·24 Feb.	1·95 Aug.
Lake Harbour	−15·4 Jan.	12·3	27	−45	44·0 July	13·4	74	25	59·4	9·40	117·1	21·21	1·10 Jan.	2·88 July
Resolution Island	− 5·2 "	12·2	39	−36	39·2 Aug.	8·8	61	27	44·4	9·17	68·9	16·06	0·47 Jan.	2·54 Sept.
Pond Inlet	−29·4 Feb.	13·9	17	−54	42·2 July	13·5	77	26	71·6	.....	.....	.....	.....	.....
Craig Harbour	−25·5 "	15·6	21	−45	40·5 "	10·6	61	29	76·0	2·32	69·9	9·31	0·18 Feb.	2·92 Oct.

POPULATION

The last official figures—those for the decennial census of 1931—give the population of the western portion of the Northwest Territories as 7,183, consisting of 3,673 Indians, 2,567 Eskimos, and 943 whites. As regards the number of white inhabitants in this part of Northern Canada, it is generally agreed that the above figure is now much too low. The increased activity in mineral prospecting and mining in the Far North in the last decade has greatly increased the proportion of white inhabitants. It had previously been the practice to consider most white residents of the Territories as transients—men who go north to fulfil certain missions for a term of years and then return to the south. The Indians and Eskimos and a number of the missionaries were regarded as permanent residents, but few white people, no matter what their occupation, became lifetime residents of the Territories. To-day, with mining activities and related services extending rapidly, the number of white residents is showing a corresponding increase the extent of which will not be definitely known until after the next decennial census, four years hence.

The figures for the 1931 census are as follows:—

POPULATION OF THE WESTERN NORTHWEST TERRITORIES ACCORDING TO THE CENSUS OF 1931

——	Total	Indian	Eskimo	White
Aklavik and District	411	180	140	91
Arctic Red River	148	132	.....	16
Baillie Island and points east as far as Pearce Point	214	.....	191	23
Baker Lake and District	414	.....	398	16
Banks Island	51	.....	49	2
Chesterfield Inlet and District	704	1	657	46
Coppermine River and Coronation Gulf District	500	.....	438	62
Fort Smith (including Indian Settlement)	343	150	.....	193
Good Hope and District	350	331	.....	19
Great Bear Lake	37	.....	.....	37
Hay River Settlement and District	171	129	9	33
Liard and District	254	225	.....	29
McPherson and District	268	255	.....	13
Norman and District	388	346	.....	42
Providence and District	318	251	.....	67
Queen Maud Gulf (including King William Island)	403	.....	399	4
Rae and District	797	766	.....	31
Reliance and District	36	8	.....	28
Resolution and District	549	465	.....	84
Simpson and District	426	343	4	79
Victoria Island	290	.....	282	8
Wrigley and District	111	91	.....	20
Totals for Area	7,183	3,673	2,567	943

NOTE.—In taking the census, no differentiation was made between full-breeds and half-breeds, and this table does not include the 373 Indians resident on the islands in Hudson and James bays.

CENSUS OF INDIANS IN NORTHWEST TERRITORIES AS TAKEN BY DEPARTMENT OF INDIAN AFFAIRS, 1934

Athabaska Agency		
Chipewyans, Fort Smith	186	186
Good Hope Agency		
Arctic Red River (Loucheux No. 6)	178	
Fort Good Hope (Hare Skins No. 5)	342	
McPherson (Loucheux No. 7)	368	
		888
Resolution Agency		
Chipewyans of Resolution	122	
Dogribs of Rae	774	
Dogribs of Resolution	293	
Slaves of Hay River	119	
Slaves of Providence	272	
Yellowknives of Resolution	142	
		1,722
Simpson Agency		
Liard (Slaves No. 8)	237	
Norman (Hare Skins No. 4)	371	
Simpson (Slaves No. 2)	341	
Wrigley (Slaves No. 3)	109	
		1,058
Total		3,854

THE INDIANS OF THE NORTHWEST TERRITORIES AND YUKON*

When the Company of Adventurers Trading into Hudson's Bay planted its flag and erected its fort at Churchill, it was invading a territory that in at least one respect reproduced the conditions that had faced the rival fur-traders on the St. Lawrence half a century before. If the small area in south-eastern Ontario where the Iroquois had introduced an alien tongue be excluded, there reigned, from the Maritime Provinces to the prairies, one language, and one only, the Algonkian; so that whether he turned his canoe eastward to New Brunswick, poleward to Labrador and northern Quebec, or westward to Ontario and northern Manitoba, the fur-trader of 1700 who had mastered the dialect spoken around the little city of Quebec could communicate readily with every Indian he encountered on his voyages. If that same trader could have extended his journeys into what we now call the Northwest Territories, he would have stumbled upon a totally different language, the Athapaskan; yet there again, by mastering only one dialect of that language, he could have conversed with all the natives along his route, from Hudson bay to beyond the Rockies and from the Churchill and Athabaska rivers to within sight of the Arctic ocean.

Several writers hold the view that this Athapaskan language which prevails throughout the whole basin of Mackenzie river, and the very similar Kutchin language spoken along Yukon river in Alaska, belong to the same family of languages as prevails throughout China, Siam, and Tibet. Moreover, from the concentration of Athapaskan and Kutchin in the northlands of America, they argue that the tribes speaking these languages were the last wanderers to drift from Asia across Bering strait into the New World before Europeans bridged the Atlantic and Pacific oceans with their sailing vessels and introduced peoples from every part of the globe into this hemisphere. Their theory may well be true. Students of the subject are fairly confident, nevertheless, that the immigration of the Athapaskans was not recent, that it must have preceded the

* By Diamond Jenness, Chief, Division of Anthropology, National Museum, Department of Mines and Resources.

Christian era, possibly by as long as 2,000 years. From the Indians themselves, of course, no knowledge can be gleaned of their origin or early movements, because they were ignorant of writing in pre-European times. Their oral traditions are wholly unreliable, for they combine with impossible fables memories of events no older than 150 years.

We must not overlook the fact that the Northwest and Yukon Territories are not the Athapaskans' only home. On the contrary, peoples speaking the same language extend, on the western side of the Rockies, over half the interior of British Columbia, thence sporadically all down the western plateau into California, and even into the arid southwest of the United States, where the Apache and Navaho Indians speak dialects of the same tongue. It is known, however, that the two tribes just mentioned did not reach the southwest of the United States until about the 14th century A.D., because it was not until then that they disturbed the slowly developing civilization of the neighbouring Pueblo peoples. From this and other indications it is conjectured that at the beginning of the Christian era the Athapaskans were concentrated in the northwest corner of the continent, in the valleys of the Yukon and lower Mackenzie. Thence, for some unknown reason, they suddenly began to expand. Some of them dribbled down the western side of the Rockies into the United States, others spread over the whole basin of Mackenzie river until they impinged on the plains, and, farther east, abutted on the territory of the Cree Indians beyond which they could not pass. Gradually the movement spent its force. But long after it had seemingly died away European influences in one place gave it a further impetus; for the introduction of horses and firearms caused the Sarcee Indians (now located on a reserve near Calgary) to move out of the forested Athabaska district of northern Alberta and to join the buffalo-hunting tribes on the plains, tribes that were alien to them in both customs and language. To-day these Sarcee Indians resemble so closely the other plains' tribes, particularly the Blackfoot, that only their Athapaskan tongue preserves the clue to their origin.

To return, however, to our Indians in the Northwest and Yukon Territories. When they first came within our view, less than two centuries ago, they seem to have been divided into nine tribes that were distributed in the following manner:—

1. *Chipewyan*, the largest and most numerous of all the nine tribes. It controlled a vast triangular area enclosed by three lines; one running from Churchill to the height of land separating the headwaters of Thelon and Back rivers; another running south past the eastern ends of Great Slave and Athabaska lakes to Churchill river, and a third east to the coast a little south of Churchill.

2. *Dogrib*, occupying the territory between Great Slave and Great Bear lakes.

3. *Yellowknife*, a rather small tribe east of the Dogrib, that controlled the east end of Great Slave lake and the country to the north and northwest, including the western end of Great Bear lake, but not extending to the Arctic ocean.

4. *Beaver*, occupying the basin of Peace river below its junction with the Smoky, the district around lake Claire, and the valley of Athabaska river as far as Clearwater river and Methy portage.

5. *Slave*, located around Athabaska lake, Slave river, and the western half of Great Slave lake.

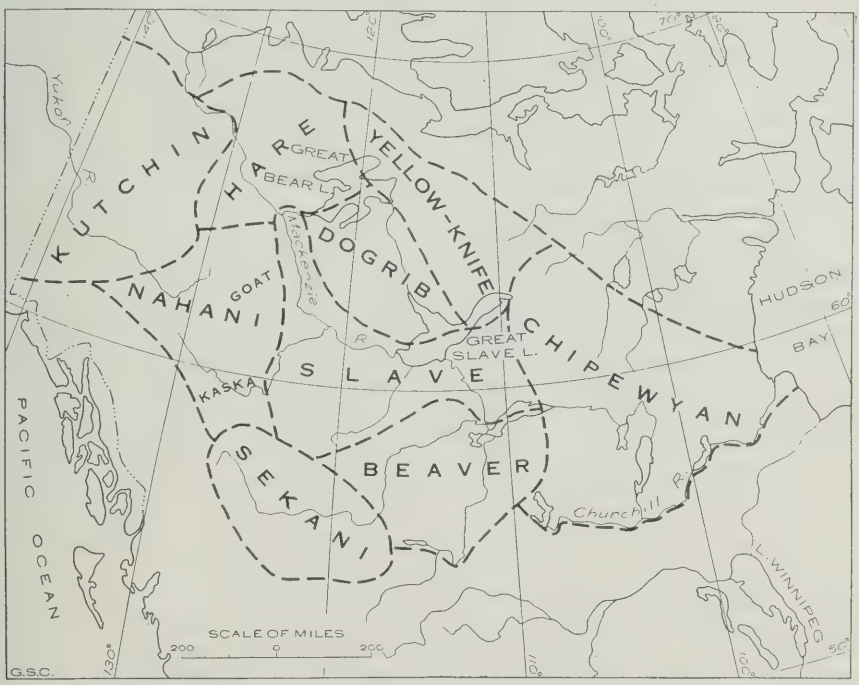
6. *Hare*, occupying both banks of Mackenzie river from Norman to The Ramparts near the head of the delta.

7. *Sekani*, controlling the valleys of Parsnip and Finlay rivers, and the valley of the Peace as far down as the modern town of Peace River.

8. *Nahani,* inhabiting the mountainous region from a little south of the upper Liard river north to about the 64th parallel.

9. *Kutchin,* occupying the basin of Yukon river, and the basin of the Peel down to its junction with the Mackenzie. Early writers gave the name Loucheux to its eastern bands on Peel and Porcupine rivers.

The accompanying sketch-map outlines the positions of these tribes and their approximate boundaries.



Approximate Distribution of Mackenzie River and Yukon Tribes in 1725 A.D.

One tribe, and one tribe only, the Chipewyan, impinged on the ocean; and even the Chipewyan derived no benefit from their narrow strip of coastline until the Hudson's Bay Company established its trading-post at Churchill. The Athapaskan tribes were essentially woodland people, even more so than the Indians of Eastern Canada. They feared the treeless Arctic shoreline, not knowing, like the Eskimo, how to hunt the mammals of the sea, to build snow huts, or to cook their meat and warm their dwellings with burning fat and oil. They avoided in winter, too, the treeless "barren grounds" west of Hudson bay, although in summer the Yellowknife and Chipewyan Indians commonly pursued the multitudinous herds of caribou that roamed over that waste. Their real home was the timber-lands, where their bark canoes in summer, and their snowshoes in winter, carried them wherever they listed, and their fires never went out from lack of wood. Of all the Indians in Canada they were probably the least ambitious or progressive, partly, no doubt, owing to their environment, for the climate was harsher and life more difficult in the Mackenzie River basin than anywhere else outside of Labrador and the Arctic coast. Yet this cannot have been the only reason. One cannot help suspecting that they had lost the enterprise and energy that had impelled them to migrate into America and to expand over its northlands—that the long trekking had weakened them and bequeathed only such vigour as was necessary for survival.

These Indians have been spoken of as tribes in the above statements, but the word tribe may be a misnomer. Nowhere could one find a duly constituted governing body or chief. The unit of society was the individual family, and families that were closely akin united together to form a loose band. The composition of this band, however, was not stable, for a family might join one at one season and another at another. Neither did it elect a leader, but followed its most influential man, obeying him only when it approved of his wishes or feared to brook his resentment. A strong, capable man, especially if, like Mattonabee, the companion of the explorer Samuel Hearne, he did not shrink from violence to gain his ends, could muster around him a considerable body of followers, and dominate other bands in his neighbourhood; but the moment his strength left him his influence waned, and his band either dispersed or followed a rival leader. The ties of kinship and relationship generally sufficed to maintain harmony within the band, and also with neighbouring bands. It was rare for several bands to join together, even for a few days, owing to the lack of a concentrated food supply. The bands that did occasionally unite and intermarry were those that spoke a common dialect, and it is to a group of such bands that the word tribe is here applied; for just as in England one cannot distinguish a Yorkshireman from a Somersetshire man except by his dialect, so in the Mackenzie River basin the outward appearance and manners of the Athapaskans were often so much alike that it was impossible to determine a man's tribe except by his speech. Consequently, if we use the term tribe to cover their dialectal divisions and the feeble political separations these differences engendered, we do so only because our language seems to have no other word available.

In appearance the average Athapaskan Indian is in no way remarkable. His stature is moderate, his build rather slender. The face, of a tan colour, inclines toward the oval; the hair is black and straight; and the cheekbones slightly prominent. The dark eyes often reveal traces of the Mongolian fold, especially in children. Lips and nose arouse no attention; one never sees the prominent beaked nose so characteristic of the plains' Indians to the south. The face has often a melancholy expression, particularly in the presence of Europeans; in his own camp the Indian will laugh and joke, but temperamentally he lacks the unfailing cheerfulness of the neighbouring Eskimo. Though inured to hardships, and courageous amid perils with which he is familiar, he seems nevertheless to lack personality and stamina, and too often becomes gloomy and morose when faced with unusual difficulties. There are, of course, many exceptions. It may seem unfair to judge the underlying character of the people from its manifestation to-day, when life (though securer, except for diseases) is much more complex, and the environment is altering so rapidly that the Indians cannot keep pace with its changes; but their early relations with one another, and with the tribes around them, seem to bear out the judgment that has been formulated above.

Travellers down the Mackenzie are familiar with the present-day dwellings of the Indians, the frame houses and rectangular cloth tents that imitate the dwellings of the Europeans in their midst. The tribes on the fringe of the "barren grounds" formerly lived throughout the year in conical tents of caribou skin that resembled the familiar teepee of the plains' Indian, but lacked the 'ears' or ventilators. The Indians along Mackenzie river, however, and those farther to the westward, seldom obtained more caribou than they needed for their clothing. Hence most of them used a spruce-bark covering for their conical tents, and, when winter overtook them, erected oblong lodges of poles chinked with moss and roofed with boughs or spruce-bark. The Kutchin of the Yukon had a dwelling all their own; they planted in the ground a circle of long willow stakes, lashed the tips to form the frame of a dome, then covered the dome with caribou hides, leaving a small opening to serve as a chimney. The winter

snow that piled round the base of this dwelling kept out the icy draught, so that it was really more comfortable than either the conical lodge or the oblong hut. Yet the Kutchin did not invent it themselves. Some Ojibwa Indians in northern Ontario still live in such dwellings, though they use coverings of birch-bark instead of skin; and all over Canada the natives erected similar though smaller domed lodges for sudatories or vapour-baths.

Spruce-bark Hut, McLeod Lake

The present-day Athapaskan has copied not only the dwelling of the European, but also his clothing. He wears a shirt, trousers and coat of European cloth, a hat of European manufacture, woollen socks, and quite frequently European boots. The old-fashioned moccasin, however, holds its ground, though ornamented with beads (more rarely with silk) instead of with porcupine quills; and the old fur or leather mittens, often similarly ornamented, are still preferred as a rule to European gloves. In place of trousers most of the men wore originally a breech-clout and long leggings made from the hide of the moose or caribou; but the mountain tribes, the Sekani and the Nahani, omitted the breech-clout; the Slave substituted a tassel for it; and the Kutchin wore real fur trousers after the manner of the Eskimo. The shirts, too, were of skin, generally of caribou fur, but, where caribou were scarce, as among the Hare and some of the Slave, of woven hare-skin. Several tribes fitted a capote or hood to the shirt; those who lacked hoods wore caps of mink, beaver, and other furs, in cold weather. In certain districts it was customary to unite the leggings with the moccasins; elsewhere the two were separate garments.

The women's costume differed slightly from the men's. Their skin shirt was longer, forming really a dress that extended nearly to the ankles. Consequently they dispensed with the breech-clout, and their leggings reached only to the knees. Both sexes kept fur robes to wrap around their shoulders whenever the temperature required them.

Nearly all primitive peoples delight in ornaments, and their men, curiously enough, generally adorn themselves more than the women. The Athapaskans were no exception. The Kutchin Indian of the Yukon basin gave a certain piquancy to his shirt by cutting it away at the sides so that it was pointed before and behind; then he added long fringes all around the edges and decorated

the shoulders, the back and the front with embroidery in dyed porcupine quills. The tribes in the Mackenzie River basin also delighted in long fringes and embroidery of porcupine quills or moosehair. The Slave and Dogrib men often wore a very striking headband that was embroidered with coloured quillwork and decorated with animal claws and the white skins of the ermine. No Mackenzie Indian, however, could quite compete with a real Kutchin dandy, who wore headbands, nose pendants and necklaces of white dentalium-shell beads, plastered his face with red ochre and black lead, his head with red ochre and grease, then planted bright feathers in his hair at jaunty angles. Nearly everywhere, indeed, men painted their faces, and both sexes often tattooed them, the men preferring parallel bars across each cheek, the women radiating lines extending from the lower lip to the chin. It is hardly necessary to say that all these forms of decoration belong to the past. The ubiquitous beadwork that to-day covers moccasins, mittens, leather coats, bags, and gun-cases, however skilfully applied, has not the same restful charm as the old porcupine quillwork softly coloured with vegetable dyes. What little quillwork survives has been coloured with the harsher aniline dyes, and even this is becoming rarer every year.

Chipewyan in Birch-bark Canoe

The network of rivers and lakes throughout the northland favoured water transport during the summer months. Every Indian family, therefore, possessed a canoe, nearly always made of spruce-bark, because birch-bark of sufficient size was seldom procurable, and then only along the southern border of the territory. In emergencies some of the Indians covered their boats with moose-hides instead of with bark. One may still see such boats at Norman when the so-called Mountain Indians (really a mixed band of Hare) bring in their winter's catch of furs; they descend Keele river in their moose-hide boats, dispose of the hides when they dispose of their furs, and return to the mountains on foot. In winter the canoe was replaced by the snowshoe and the toboggan, the latter nearly always drawn by women and girls, because the Indians possessed few dogs (and those of a small breed useful only for hunting), and the men had to march light in order that they might rush off in pursuit of game at a moment's notice. Their toboggans were consequently rather smaller than those they use to-day. In compensation, their household goods were more limited. Besides the tent, and a few articles of spare clothing that were packed in bags of solid skin or of babiche (slender thong) mesh, they carried only a watertight vessel

of spruce-bark or of woven spruce-roots[1] in which they cooked their meat by means of heated stones, an adze with a stone or copper blade, used mainly for gathering fuel, one or two bark dishes, some spoons of wood or horn, knives with stone, bone or beaver-tooth blades, and a few articles, such as nets and ice-chisels, that they required for fishing and hunting. If we add to this list, however, whatever food they had laid by, and little children too weak to plod from daylight till dark through the yielding snow, we can understand that the loads dragged by the women were not light. For three or four days each month, too, the women suffered additional hardship, because a foolish superstition prohibited them at such times from following in the tracks of their masters, and forced them to break new trails over to one side. Their lot was no easier during the summer months whenever they travelled overland instead of by canoe, for then they carried the family impedimenta on their backs suspended from tump-lines, while their men, as a rule, again marched light. In one or two tribes, indeed (notably among the Slave and the Hare) husbands did try to ease their wives' burdens, and, whenever possible, themselves gathered the fuel and set up the tents. Yet we cannot wonder that infanticide was common, and that many of the Athapaskans deliberately abandoned their aged and infirm to die of starvation and exposure.

What kept the Indians constantly in motion was the unceasing quest for food. Rarely could they obtain enough food in one place to sustain them more than three or four weeks. Agriculture was entirely unknown to them, even in such places as it was possible; they depended solely on the fish in the water, the game on land, and the few berries they could gather in the summer months. There were no firearms to help them in their quest, no implements of metal, if we except the pure copper that the Yellowknife found near Coppermine river and hammered into knives, spear-blades, and arrow-points. Their weapon against land game was the bow and arrow; but more effective than this was the babiche snare, which they used for every animal except the bear, the beaver, and the buffalo; even the mighty moose fell entangled in its coil. The Beaver Indians of Peace river, and the Nahani at the headwaters of the Liard, drove the buffalo into pounds in much the same manner as the Indians of the great plains. The Kutchin of the Yukon, and the tribes that fringed the "barren grounds" —the Chipewyan, Yellowknife, and Dogrib—built smaller pounds (generally set with snares) for caribou, but only during the winter months; in summer they drove the herds into lakes and rivers, where they speared them from canoes. Neither of these methods, however, was applicable to the larger caribou of the forests, which does not roam in herds.

The Indians preferred for food the meat of the caribou, whose skin they required for their clothing; but it varied in abundance both regionally and seasonally. It was least plentiful in the territories of the Hare and Slave Indians. These two tribes subsisted mainly on smaller game and on fish; the Hare Indians, indeed, owed their name to the conspicuous rôle that animal played in both their diet and their clothing. Several tribes hunted the beaver assiduously, and the Sekani and Nahani, the marmot. The moose was everywhere a trophy, and the Chipewyan killed a few musk-oxen; but in most places no animal except the caribou appeared on the menu half as frequently as fish.

The Indians had many devices for catching fish, not all of them employed, of course, in every district. Common nearly everywhere was the bone fish-hook, trolled from a canoe in summer, and jigged in winter through a hole in the ice. Almost equally common was the trident, used from the canoe in night-fishing by torch-light, and in winter with a lure dropped through the ice. The natives secured their largest catches, however, with seines made of either willow-bark

[1] The Chipewyan used birch-bark cooking vessels, a usage they probably learned from the neighbouring Cree

or caribou-hide thongs (babiche). The Kutchin differed from all other tribes in employing also a dip-net and a fish-basket, devices they learned from the Tlinkit Indians of the Pacific coast.

The same weapons that the Indians used for hunting—the bow and arrow, the spear, and the club—served them also in war. Some added a wooden shield and a cuirass of willow twigs, which they quickly discarded as soon as they obtained firearms at the end of the 18th century and the beginning of the 19th. Organized warfare, as we know it, was impossible to the semi-leaderless bands, but small parties frequently encroached on the hunting-grounds of neighbouring tribes, or on lands that other tribes claimed as their hunting-grounds, for there were no sharply delineated boundaries. In such cases one or other, if superior in numbers, launched a surprise attack, and slaughtered men, women, and children without mercy, preserving only a few of the younger women to carry away as wives. An open declaration of hostility, or a hand-to-hand combat on approximately equal terms, they considered the height of folly; and they never voluntarily committed themselves to a fight unless their own safety and success seemed a foregone conclusion. Nature had not moulded them to be warriors, like the Iroquois of Eastern Canada, and their fights were not genuine tests of courage, but bloody massacres. The Chipeywan companions of Samuel Hearne ran true to type when they wantonly slaughtered a defenceless band of Eskimo near the mouth of Coppermine river. During the following half-century the Dogrib and Yellowknife Indians massacred each other in exactly the same manner.

A woman's lot among the Athapaskans was clearly not an enviable one. Married while still adolescent, she was the prize of every conqueror as long as she retained her beauty. Men of her own band might wrestle to possess her, and, willy nilly, she had to follow the victor. If her lord and master was a capable hunter, he might bring in other wives to share her tent, to dry his meat and fish, cook his meals, tan and sew the skins he brought in from his hunting, and help to carry his possessions. If the co-wives quarrelled, he quickly brought them to submission with a cudgel. At all times subject to restrictions, women received no consideration during pregnancy, rarely any help in childbirth, and no release from their duties either before or after their delivery. Among the Kutchin, where women might not even eat with their husbands, mothers sometimes deliberately destroyed their girl babies to save them from the hardships they would inevitably suffer in later life. We must not forget, however, that many of these hardships arose not from intentional ill-usage, but from pitiful superstitions, and that not all husbands were as harsh as the Chipewyan, the Yellowknife, and the Kutchin. In many districts, though the same superstitions prevailed, men did treat their women gently, and relieve them of many unnecessary burdens. Human nature, indeed, could not be what it is were not numerous marriages happy, even among savages. Furthermore, life in the Northwest Territories, among peoples divorced from all contact with the outside world, inevitably involved many unusual hardships, which the women were bound to share with their men.

There was never any marriage ceremony among the Athapaskans beyond a small feast at the home of the bride's parents. The young husband served his parents-in-law for a year. Whether he lived in the same tent with them, or erected a tent beside theirs, he had to present them with everything he obtained from the chase and from the waters, retaining barely enough to support himself and his bride. His obligations ceased at the end of the year, or, alternatively, at the birth of their first child, when the young husband dropped his name and was henceforward known as the father of his child. Women generally carried their babies in bags of fur, but the Chipewyan followed the Eskimo practice of strapping the child against the naked back under the skin dress, and the Kutchin often used a birch-bark cradle shaped something like a Mexican saddle. There

were never many children in a family, or at least few were allowed to survive owing to the difficulty of raising them. Adolescent girls went into seclusion for a term and thereafter kept strictly aloof from boys until their marriage; and boys at the same period of life fasted to gain a protecting spirit.

Hare Indian Woman and Child

The inferior status of Athapaskan women showed itself in the divorce customs. Whereas girls and very young boys always followed the divorced mother (who moved into the tent of a new husband or fell back for support on her kinfolk), boys who were old enough to take part in the chase nearly always remained with the father. These rules did not hold among the Kutchin, who, like the Pacific Coast Indians, and the Highlanders of Scotland, had organized themselves into clans. Kutchin clans, however, differed from the Scottish in two very important respects; first, every child, boy or girl, belonged to his mother's clan, not to his father's; and, second, no man was allowed to marry a woman of his own clan. Thus their society was a matrilineal one; descent followed the female line, not the male, and a woman's children sought protection from her brothers almost as much as from their father. According to some armchair philosophers such an arrangement, not uncommon in other parts of the world, inevitably increases the authority of the women and improves their

status; but this was certainly not the case among the Kutchin. On the contrary, they kept their women in greater subjection than most people, granting them one privilege, and one only, the very doubtful one of choosing husbands for their daughters.

However primitive man may be or however hard his environment, he cannot live without some distractions to lighten his daily toil. Festivals were rare in the Northwest Territories. A few tribes held annual feasts to the dead, and two, the Hare and the Dogrib, lunar feasts on the occasion of each new moon; but these were insignificant affairs. Medicine-men sometimes entertained a band with such tricks as the "sword-swallowing" witnessed by Samuel Hearne, and the Indians knew three or four very simple games; but the principal diversions were gambling and dancing. The old gambling game survives with little change among the modern natives, and can still be witnessed at every trading post along Mackenzie river. Briefly, the players sit or kneel in two opposing ranks, the champion on one side. Amid wild singing and frenzied drum-beats, he deftly shuffles from hand to hand four small balls, one marked, the others unmarked, and the champion of the other side guesses which hand conceals the marked ball. In their early dancing, men and women did not mingle but lined up in separate circles, when the men capered around while the women shuffled with their feet. The modern Indian, however, has forgotten the ancient dances, and whiles away the evening hours at two-steps and other figures he has learned from the whites.

Dogrib Camp

Sooner or later earthly pleasures cease and death knocks imperiously at each man's door. If outward lamentations ever truly indicated the depth of grief, the Athapaskans must have felt his knocking more keenly than most people. Not only did they weep and sing mournful songs, but they destroyed all the family property. In most places the women (sometimes, too, the men) gashed their bodies with sharp knives. Usually they laid out the corpse in its

hut (which they then abandoned), or they deposited it in a tree or on a platform. The Kutchin, the Nahani, and, for a period, the Sekani, cremated it, while the Chipewyan deliberately exposed it on the bare ground to the ravages of birds and foxes. What lay beyond the grave they could no more fathom than others. A few consoled themselves with the hope of a happy land beyond some mysterious lake or river where they would rejoin their kinsmen and friends. Many believed in the possibility of reincarnation, though the prospect carried with it no pleasure. To the majority death was a yawning chasm into whose darkness every one tumbled sooner or later, and whatever existence might continue after the plunge was too shadowy and uncertain to pin any hopes upon.

Europeans, oppressed by the imminence of death, turn for comfort to their religion; but to the Athapaskan even this solace was denied. The vision of a Deity governing the whole universe, one who could hear his prayers and strengthen his soul, was never vouchsafed to him; nor had he, like the ancient Greeks and Romans, a pantheon of deities to one or other of whom he could turn in his hour of need. His imagination pictured a world filled with sentient beings of various shapes and powers—with animals, birds and fanciful creatures that belonged to exactly the same order of creation as himself, though clothed externally with different forms. Like himself, they possessed souls or spirits, and these spirits could dissociate themselves temporarily from their bodies, as his own soul appeared to do in dreams. Not without logic, then, he tried to enroll them in his service, to join their powers with his; for he knew only too well his own weaknesses, and the perils that constantly beset his path. Youths therefore fasted and prayed that they might receive one or more spirits as protectors; and visions and hallucinations of extraordinary vividness, combined with a little professional training, qualified a man to become a shaman, credited with power to heal and cause diseases, and to discover objects invisible to normal eyes.

The Athapaskans, unlike the Indians of Eastern Canada, knew very few herbal remedies. The shaman who was called in to treat a patient suffering from some internal malady sucked over the afflicted organ and extracted, or pretended to extract, a splinter of bone or other object that he claimed to be responsible for the complaint. If his method, strangely enough, succeeded in many cases, this was only because the patient's implicit faith in his "physician" brought into play psychological factors that really did have potency to produce the desired result.

With the coming of Europeans most of the customs and beliefs above described gradually vanished. The old tools of stone, bone, antler and native copper naturally disappeared very quickly, and the old style of dress soon followed them. Intertribal raids came to an end about a century ago, and the Indians began to congregate about the posts and settlements of the fur-traders, who tried, not very successfully, to elevate as chiefs the most influential and reliable hunters and to give them a limited authority over their countrymen. Missionaries introduced new and larger ideas of life and its purpose that partly supplanted, partly coalesced, with the older notions. In consequence every Indian in the Territories to-day adheres to the Anglican or the Roman Catholic faith, though he may still harbour many of his old superstitions. European exploration and settlement, in recent years also mining activities, have led to a steady demand for Indian guides, canoe-men, and packers, and required an increasing dependence on flour, beans, bacon, and other imported foods instead of on the vagaries of hunting and fishing. From the earliest times, too, many white traders and trappers have taken Indian women as wives, and more or less consciously leavened the whole outlook and manners of the tribes among whom they have resided. So great, indeed, has been this intermarriage that to-day in the whole area there are probably few Indians of pure stock.

Thus through economic and social changes both the outward and the inward lives of the Indians have changed. Over a long period—most of the 19th century—these changes threatened to be disastrous, to bring about the extinction of the race. Alcoholic excesses and diseases previously unknown, particularly smallpox, tuberculosis, and influenza, decimated their ranks and reduced their number from about 13,000 to one-third of that total. Even to-day influenza and tuberculosis take a heavy toll of lives. Nevertheless, the outlook for the future has become much more promising. It is confidently felt that increasing settlement, and a greater development of the resources of the Territories, will open up new avenues of employment for the Indians, lower their heavy infant mortality, and through a general improvement in the living conditions arouse in them new vigour and new ambitions. Of their ultimate fate there can be little doubt. Within another hundred years they will become completely absorbed into the white race and retain of their past history but the vaguest memory.

PRESENT DAY ESKIMOS OF THE CANADIAN WESTERN ARCTIC*

In Canada, the Eskimos inhabit the entire Arctic coast from the Yukon-Alaska boundary to the eastern limits of Canadian territory, the more southerly islands of the Arctic archipelago, and some of the islands in Hudson bay. The people dealt with specifically in this section are those Eskimos who inhabit the western Canadian Arctic coast from the International Boundary east through Coronation gulf to Queen Maud gulf, King William island, and Boothia peninsula. From the common point of view the land along the coast is barren but while the Eskimos go inland on their hunting expeditions, particularly for caribou, the greater portion of their time is spent upon the coast. One exception to this is in the Mackenzie delta where for some years a number of Eskimos have inhabited timbered country. Only a few do this, for as a rule Eskimos dislike being shut in by trees. Further, as a result of habits and experience extending over generations they are naturally at their best when securing their livelihood in the "barren lands" or on the sea.

On the coast itself there is a short season of open water in midsummer, but for eight or nine months of the year the sea is frozen over, and travelling thereon seems no different from travelling over flat land areas. In fact it is often necessary when travelling, if one is doubtful of his location, to dig through the snow to see whether there is soil or ice underneath. So that to all intents and purposes the Arctic ocean itself, for a period of at least eight months, provides a happy hunting ground for the Eskimo, and he travels and lives on it as if it were solid ground.

The Eskimos are a sturdy race with good physique, straight dark hair and dark eyes, the eyes having a distinctly Asiatic slant, rather broad, flat faces, and with a skin which, when exposed to the continuous daylight of the spring and early summer, "snowburns" to almost a black. Although fatter than the average European they are very active and possessed of great endurance. The women are little smaller than the men and are equally strong. Accustomed to hard work in their homes, many of them hunt and trap as efficiently as the men.

Many people suppose that the Eskimos are a diminutive people. This is only partly true. In the Mackenzie delta and the western portion of the Canadian Arctic, many of them are tall, fine-looking people, some of the men standing over six feet tall and weighing over two hundred pounds. Many of the women are five feet seven inches in height, or over, with an occasional

* By J. A. Urquhart, Medical Officer, Department of Mines and Resources, at Aklavik, N.W.T.

"six-footer" among them. Around Coronation gulf and towards King William island the Eskimos are shorter in height by as much as six inches, but they still have the same sturdy build and are capable of doing hard work for long hours. As a rule their faces are pleasant, with the characteristic grin or smile which is most noticeable when one first comes among them. Both men and women are highly intelligent, quick to imitate or learn, and with a mechanical turn of mind that permits them rapidly to take advantage of mechanical power and labour-saving devices. Their outlook on life is cheerful, their dispositions are friendly, and most of them have a keen sense of humour.

In their own homes they are very pleasant. The men and women never quarrel. A number of families group together for the season's activities, and existence in the group is markedly communal in character. In the individual home, life seems to be of the character of a partnership, the outstanding feature of which is their common love for their children, whom they "spoil" to a marked degree and never by any chance correct or chastise.

In general they are much cleaner than one would imagine, washing and sponging themselves at regular intervals. Their habit of eating "high" fish and meat, plus the universal wearing of home-tanned skin clothing lends a distinctive odour to an Eskimo home that is often mistaken for uncleanliness. Even this, however, is not nearly as bad as might be imagined.

Eskimo Family, Aklavik

The type of habitation used by the Eskimos depends upon local and seasonal conditions. Whenever possible, the Eskimos have "permanent" homes in which they reside during the winter months, although the location of these homes may be changed every few seasons. While the Eskimos do not ordinarily live in

timbered country, there is within a wide radius of the mouths of many of the rivers, considerable drift-wood, which they salvage, and out of which they build log-houses. The drift-wood is also used for fuel. These houses are invariably one-roomed, with sleeping benches and sometimes beds at one end. The beds are usually made of poles covered with raw caribou skin and then sleeping robes. As often as not two families will occupy the one house. The stove is in the end opposite to the beds and the occupants share the housework. This is their permanent winter abode and trapping base, and if the country surrounding is good trapping country, two or three houses will be built at the same spot. The two factors on which the location of a house depends are, of course, available drift-wood, and, equally important, good fishing or sealing. Strangers are gladly welcomed and the banding together of three or four congenial families banishes loneliness from their midst.

On the coast the Eskimos move out on the ice to sealing grounds, and it is then that the snow-house is utilized by many of them. There are, of course, some locations where drift-wood is not available, and the snow-house is used throughout the entire winter. In other places, where caribou are not to be found, groups of families will maintain sealing camps on the ice, which they also use as a base for their trapping operations during the winter season.

Travelling over Flooded Sea Ice in Late Spring in Coronation Gulf Area

These sealing camps may be from five to eighteen or twenty miles out on the ice and the hard, drifted snow which covers the Arctic ice-pack throughout the winter is the building material. Blocks of snow are cut out with a long snow-knife and the houses are built circular in shape, with a dome top, very much like a beehive. On the leeward side according to the prevailing wind a door is left, and this is protected by a snow entrance or porch. Some of these snow-houses are large enough to accommodate two or three families; others, of a more temporary nature, may be only big enough for two. A hole is left at the top for ventilation and while occasionally blubber is still used for heating, the modern Eskimo uses a Primus stove, burning coal-oil for both heating and cooking. The house is carefully chinked, and after a few hours with heat inside, the interior becomes encrusted with an icy coating. It is really warm and draught-free, and strong enough to bear the weight of a man on the top. In a short time the wind drifts snow about the houses and little can be seen except the vent pipe at the top. The entrance, which is invariably occupied by the dogs, closely resembles the entrance to a cellar. When there are a number of families they build their houses close together and usually have snow-covered communication passages between the houses.

Whether big or little, each house consists of one room, about half of it being occupied by a raised sleeping platform, which is covered with raw skins, more to keep out the cold from the snow and ice below than with any idea of softness. The entire family uses the same sleeping bench, and if there are visitors it is often quite crowded. Sleeping closely together they keep each other warm and thus a minimum of fuel is required. Coal-oil is expensive, but seal-oil, or blubber, is valuable not only as fuel but as food for themselves and their necessary dogs.

Naturally it is not easy to keep such a house clean, but the sealing camps must be shifted every few weeks. The Eskimos simply move to new ground, build new houses and thus avoid all the trouble of house-cleaning. All traces of the camps and their refuse disappear when the ice breaks up in the summer. No snow-house is occupied long enough for it to become germ ridden, and because it is used but once, probably accounts for the Eskimo's comparative freedom from many diseases.

With the onset of spring, when the season for foxes is over, the Eskimos move to temporary quarters which are occupied until the seasonal break-up. In the Mackenzie delta these temporary quarters consist of "ratting" camps, usually tents, where the natives remain, hunting muskrats and living under canvas until the season of open water arrives.

The summer existence of the natives depends largely upon their prosperity, and to a lesser degree upon location. Those who own whale-boats put them in order with the first open water and proceed to the whaling grounds where they fish for white whale. Here they either live in their boats or establish tents on shore. The white whale is taken by Eskimos in nets and by shooting. A small power-boat is capable of keeping up with a school while individual animals are shot in the open sea. The nets are very cumbersome and expensive and consequently their use is limited. In some localities the natives will make a "drive" of these porpoises, herding them into shallow water where they are stranded and easily dispatched. A successful whaling season means prosperity for all. The flesh of the white whale is used for food, both for human consumption and for dogs. The blubber, which is the really valuable part, has the oil extracted and this oil, or "ookchuk" forms part of practically every meal. It is stored up in barrels or sealskin bags for winter use, and the prosperity of any native is more or less gauged by the amount of oil he has.

Natives who have no whale-boats, live throughout the summer in tents, often made of skin, and carry on their fishing and whaling from the shore. Naturally, without this necessary equipment, their success is not so great. The seal is no very great factor to them during the early summer, as the animals are thin and sink rapidly if shot, rarely being recovered, but inasmuch as fish are plentiful the lack of seal meat is no hardship. The last month of the very short summer is usually spent in sealing. The animals are now fat, do not sink so rapidly and consequently are easily secured. At this time they use the meat as a staple article of diet. The oil from the blubber is not as choice as that of the white whale and though often eaten by the natives it is more often used as dog feed. The sealskin—and to avoid confusion it should be borne in mind that this is the hair seal[1] and not the valuable fur-bearer—is used extensively. From it the Eskimos make waterproof boots, and very often parkas (long outer smocks or snow shirts) when caribou skins are not procurable, and it is the skin of this seal that is used in the construction of the native kayaks or skin boats. The skin of the white whale is also used to make waterproof boots. It is, however, not nearly as durable, although beautifully white in colour, and is most commonly used for their best, or dress boots.

[1]Hair seal is the common term for the Harbour Seal, the Ringed Seal, the Greenland or Harp Seal, and the Bearded Seal.

By the end of September the Eskimos are back again at their winter quarters and now comes their very busy time. They fish assiduously during the entire month of October, and this is accomplished by setting their nets under the ice, for freeze-up occurs early in that month. The amount of fish required by an Eskimo family appears to us enormous. They eat huge amounts themselves and require large quantities for their dogs, and an Eskimo who starts the winter with less than 8,000 or 10,000 fish can look forward to lean days ahead. The fish they get are herring, white fish, and inconnu, and the natives prefer them in that order. A large proportion of the fish catch is eaten raw and frozen, and even to the white man's palate "quawk" or frozen fish is improved by being slightly "high." This custom of eating raw fish, while not natural to white men, is actually a very good thing for the Eskimos. They live in a country where there are few fresh vegetables and even though canned vegetables are available to a limited extent, the natives, not being accustomed to them, do not like them. It is obvious then that they must get their supply of "live" food containing vitamins from some other source, and this source is raw oil, raw fish, and raw meat. Scurvy is to them a disease unknown, and this is the explanation.

Eskimo Splitting Fish at Coronation Gulf

On the fifteenth of November the trapping season for the white fox opens and the natives then engage industriously in that pursuit. They have no use for the white fox skin themselves, but it has a ready market and might almost be called the currency of the country. After a successful trapping season the Eskimo trapper is in a position to purchase clothing, especially underwear—far superior in his eye to anything made with skins—and this clothing, plus shirt and trousers, is commonly worn under his outer skin garments. The Eskimos are also developing a taste for flour and bread, butter, tea and jam, and it is for the purchase of these supplies, which in the light of their changing ideas go far towards making their lives much more livable, that they trap the fox at all. In fortunate years they may even have an excess of fox pelts, and if this is sufficient they will purchase new rifles, ammunition, and, even power-boats of some sort. All of their activities demand transport. The only possible means in the winter is the dog-team. Without dogs the natives are tied to their camps and can neither hunt nor trap. In the summer, possession of a power-boat ensures transportation to a good fishing ground, and is almost a guarantee of a really good whaling and sealing season, which, as has already been said, means actual prosperity to them.

The one food that Eskimos really crave, and which the country itself supplies, is fresh meat. Seal meat is the staple, but caribou meat, when obtainable, is the most prized. Caribou hunting for meat extends throughout the winter and organized expeditions of ten, twenty, or even more hunters are made from time to time for the purpose of securing meat. In addition, caribou skins make infinitely better fur clothing than can be obtained from any other source. The back sinew supplies the best thread and while sinew can be obtained from other sources such as foxes, the Eskimos much prefer caribou because a greater quantity can be obtained from one animal and the strands are longer and more easily worked.

Fleet of Eskimo Schooners at Herschel Island

In the above brief description the Eskimos have been followed through the annual rotation of activities and it will be noticed that in the appropriate season they do the particular job which enables them to prepare for the coming winter. It can thus be easily seen that the Eskimos in general live by the year rather than by the day or by the week. They have learned that they must take advantage of seasonal opportunities at the correct time, otherwise they will suffer a distinct shortage throughout coming months. Rarely is there an opportunity to recoup, following misfortune or negligence.

Following is a description in more detail of some of their activities. In general the men take the lead and do the hunting, fishing, and trapping, while the women cut up meat and fish for drying, tan skins, make clothing, and, in addition to the cooking and caring for the children, often assist in the actual trapping. On the whale-boats they "work their passage" as crew, and in any moving of camp the women do their full share, whether it be by actual back-packing in the summer or by handling a dog-team in the winter.

Caribou hunts are conducted in much the same manner in Eskimo territory as elsewhere. These animals are still numerous in the Northwest Territories but migrate seasonally and from time to time the route of migration is changed. The reason for this change of route varies. It may be that the head of the migration has been deflected through fright or lack of grazing along a particular route. From whatever cause, the effect is frequently serious to the natives who have been depending for their meat supply upon the arrival of caribou at the usual time. Practically every year at some point the migration fails to

materialize and in that locality there will be a shortage of meat. The Eskimos there must then depend upon the sealing, or, if possible, change their location to conform to the movements of the caribou.

Fishing is conducted to a large extent with the ordinary gill nets, although in locations where there is a large run of fish, spearing is commonly resorted to, more especially if it is possible to construct a rock trap at a shallow point. This latter practice is quite common in the Coppermine area, where annually there are quite good runs of "salmon."* West of that area the rivers are muddy—and this applies particularly to the Mackenzie—and salmon do not come to muddy rivers.

Eskimo Examining Nets at Coppermine

Sealing provides more of interest. When there is open water the seals are often seen sleeping on cakes of ice. The hunter, after a cautious stalk, kills them by rifle fire. If he fails to shoot the animal through the head, it will flop about and slide into the water and be lost. The native who has a boat will watch for the seals coming up to breathe, shoot them through the head in the same manner and then hurry to get to them before they sink. All this may perhaps seem quite natural, but what does intrigue one is mid-winter sealing. There is no open water and nothing to be seen but the hard-packed snow covering the ice. Seals, however, cannot remain indefinitely under water without coming up to breathe, and during the winter months they keep holes open in the ice to which they come at regular intervals to renew their supply of air. The Eskimo uses a dog to locate these seal holes and a good sealing dog is as valuable to him as a good lead dog in his dog-team. He starts out over the ice in an area which experience has taught him is a good sealing ground, and the dog, when he comes to a seal hole, draws his master's attention to it. From that moment great care must be used. The Eskimo feels through the snow with a slender stick and locates the centre of the hole without breaking the snow covering. His next job is to erect a few blocks of snow to protect him from the wind. He then sets his slender indicator so that it just touches the water in the centre of the air hole and crouches over it with his seal spear in his hand. The spear head is detachable from the staff, but has a rawhide thong tied to it. The other end of the thong he fastens securely, often to his leg. Patience is now a virtue. The Eskimo may have to crouch over his tell-tale for a few minutes or it may be an hour or more until a movement of the indicator shows that a seal has come up to breathe. The moment this occurs he drives his spear through

* Actually the Arctic Char. See page 126.

the crust with all of his force into the body of the seal. A moment or so later he is in possession of a good supply of meat, fat, and another sealskin. On a good day a native may take five or six seals, and on a poor day none at all. If he is lucky, all in the camp share in his good fortune. When the sealing is good, all feast equally. When it is poor they all go hungry to the same degree irrespective of who kills or who does not. In all of these hunting pursuits the Eskimos are highly skilled. They must be, to exist.

Let us now deal with the occupations of the women. Many of them, as we have said before, are adepts at the vocations of the men, but in addition to this they have their own occupations which require the greatest skill. They excel in the making of clothing. They first tan the hides and then make up the garments, doing all the sewing by hand, and with sinew. The sewing must be well done because the parkas and skin trousers must be windproof, while the water-boots which are so necessary in the spring, summer, and fall, must be sewn so that they are waterproof. The tanning of the skins is more or less crude and does not entirely eliminate odour, but it is otherwise efficient, giving a soft, pliable skin to work with. The Eskimo is very particular about his clothing. The parkas are always roomy as he must have great freedom of movement, and it is very amusing to see an Eskimo man try on a new parka. These are often quite nicely decorated with a pattern of different coloured pieces of fur around the edges. However his chief concern is not with the appearance of it. He slips the parka on over his head and then promptly goes through all the violent contortions he can think of to throw as much strain on the seams as possible. If it passes this test, well and good. If not, it is tossed back to the woman, who makes whatever alterations are necessary to make it perfect.

Throughout the winter when it is cold and dry, moose skin or deer skin soles are used for the mukluks or boots. With the advent of warmer weather, when the snow begins to get damp, waterproof boots of some sort must be available and these, of course, must be manufactured at home. For fancy wear the skin of the white whale is used for soles with either canvas, cloth or fur tops. For hard wear, however, sealskin is much better and while the skin of any of the hair seals is good, the skin of the bearded seal is preferred because it is thicker and heavier. If it is merely damp underfoot waterproof soles are used with some other material for the top. If, however, much water is about, the complete water-boot made of sealskin is used. This boot reaches to the knee and all of the seams, which are sewn with sinew, must be so well done that the seams themselves are completely waterproof. The women are clever at this and it is rare indeed for a water-boot to leak, and properly cared for they will last a full season. Much has been said of the women chewing boots. To turn the toe and heel, the skin must be crimped, and as they have no crimping machines, the women chew these crimps into both the heel and toe to make the boot fit perfectly. The completed article looks as neat as if it had been crimped by a machine, but the teeth of the older women show a certain amount of wear from performing this work.

The feminine side of their character is evidenced by their attempts at decoration, and it is remarkable indeed to see what they can do with the limited materials at hand. Bits of different coloured fur are cut up and made into a sort of mosaic pattern to trim the hem of a parka, while other coloured pieces are inset at the neck, shoulders and sometimes in the arms. These, plus various bits of long-haired fur such as wolf or wolverine, make an attractive looking garment. The hood of the parka is trimmed with wolverine, if that fur is available. Many believe that the fur of the wolverine does not freeze or get frosted up. This is not correct. It does get coated with frost but the moment one gets indoors where it is warm the ice pulls off leaving a practically dry fur, whereas the fur of other animals is left wet and can be most uncomfortable.

The cooking is comparatively simple. A large proportion of the meat and fish is eaten raw and frozen, and when food is cooked, boiling or stewing is the favourite method.

The care of the babies presents a distinct problem. With the intense cold and the long winter, infants must be carefully protected. The Eskimo mother accomplishes this by wearing a very full and wide parka, usually, as a matter of fact, two parkas, one with the fur turned in and one with the fur turned out and when the Eskimo mother has to go outside with her child, she slips it, often scantily clad, onto her back under the parka. The hoods of the women's parkas are left with a distinct bulge in the back to provide room for the baby's head, so that when it is not too cold, by leaving the hood down, the infant can get a supply of fresh air. A sash tied around the parka at the waist converts it into a sack in which the baby lies comfortably, protected from the cold by a double lining of fur and warmed by its mother's body. There is even sufficient room in the parka for the mother to slide the baby around to the front without exposing it to the air when necessary to nurse it. In their homes the children play around on the floor, often with very little clothing on.

When the children are a little older and can run about they have an outfit which is an exact replica of that of their elders, and the youngsters, with their little fat faces and bulky fur clothing, resemble little woolly bears. They play as other children do, the only difference being in their games. Naturally their games are often imitations of the activities of their parents. The boys busy themselves setting snares, making miniature houses and at the first moment they are big enough to do so, attempt to drive dogs. Usually the pups are made use of for this amusement. The result in most cases is that by the time the dog has reached a size and age where he can be worked in the dog-team, he has already been trained by the children, and for the parents it is merely a matter of appropriating the dog and putting him into harness. When a boy reaches the age of nine or ten he is sufficiently skilled in dog handling to have a little team of his own—not, of course, the team of six or seven dogs that is driven by his elders, but of two, and as he gets older, of three dogs. By this time he is capable of taking his little team and following along after his father when he goes on a short trap-line, and the little Eskimo boy has his own traps and will set trap for trap with his father. It is amusing in the extreme to see father and son come back from a trip over the trap-line that the youngster is sharing. He very often beats his father, having caught more fur and is as proud as would be a child in the outside world who had won a scholarship. This early training is essential to them. They eventually must support themselves by hunting, fishing, and trapping and it is in their youth that they really learn to do these well. The normal Eskimo boy of fourteen has a knowledge of animal lore that is nearly the equal of his father's. He knows where, when, and how to set a trap to get results. In addition to that he is a skilled dog handler and at that age is a real asset to his family. To all intents and purposes he is as much of a bread-winner as his father. The only thing he lacks is the physique which he will attain in a very few years. A certain amount of education is an advantage to him but he should not acquire this at the expense of his practical lessons in natural history.

The girls have their fun playing outside just as the boys do, but at the time when the boys go out on the trap-line, the girls stay at home and take over a large part of the care of the young children, and in addition to this learn the art of tanning skins, sewing, and cooking. In the fall, after the ice has become too thick to fish with nets, holes are kept open for the purpose of jigging for fish, and the whole family, men and women, boys and girls, assist in this. A tremendous amount of their time is spent on the ice adding to the needed store of food for man and dog.

The Eskimo is cheerful, easy to deal with, intelligent, quick to learn, and an admirable patient when sick. For generations he has wrested a living, mated, and reared a family in a country where only a hardy and intelligent race could survive. He is making a very good job of slowly assimilating a certain amount of civilization while still retaining his independence, his pride, and his ability to carry on and care for himself. The vast majority of them now appreciate the value of conserving the natural resources of the country in which they live, and co-operate in that work to a remarkable degree. The Eskimo is naturally law-abiding and even though he may not always quite understand the meaning and purpose of the law, his natural tendency is to obey it. His communal life has taught him that the wishes of the individual must be subordinate to the good of the majority and this has made him especially easy to deal with. For a number of years the Government of Canada has been paying special attention to its Arctic citizens, in order to keep them independent, self-reliant, and self-supporting, and with this object in view has put forth continuous and unremitting efforts to preserve the natural resources of the country so that the Eskimos may continue to be the admirable race of people they now are.

COMMERCE AND INDUSTRY

FUR TRADE

Although in the Northwest Territories mining is rapidly approaching in importance the position held unchallenged for so many years by the fur trade, the production of furs is still the principal occupation of a large proportion of the population of the Territories.

The livelihood of the aborigines is gained by hunting and trapping, the surplus products of the chase being bartered for trade goods. At the mining camps fresh meat, legitimately secured, may be sold by the hunters and it finds a ready market. The traders' customers are largely trappers but in some areas those associated with the development of the mineral resources represent an increasingly important trade factor. However, the "currency" of the Territories is still largely composed of pelts of fur-bearing animals. The number of licensed trading posts in the district covered by this report is 178 (July 1, 1936) of which 39 are operated by the Hudson's Bay Company and 16 by Northern Traders, Limited. The value of the annual crop of furs is indicated by the following statement, published by the Dominion Bureau of Statistics in its report "Fur Production of Canada, Season 1934-35." The figures are for the whole of the Northwest Territories.

Kind	Number of Pelts	Total Value of Pelts	Average Value per Pelt
		$	$ c.
Northwest Territories—			
Bear, black and brown	66	145	2.19
Bear, grizzly	10	45	4.50
Bear, white	39	512	13.12
Beaver	11,291	108,619	9.62
Coyote or prairie wolf	133	785	5.90
Ermine (weasel)	5,715	4,401	0.77
Fisher	24	1,365	56.86
Fox, blue	427	14,945	35.00
Fox, patch or cross	4,875	104,471	21.43
Fox, red	11,789	97,967	8.31
Fox, silver	618	20,289	32.83
Fox, white	52,615	805,536	15.31
Lynx	5,829	159,365	27.34
Marten	5,543	97,003	17.50
Mink	11,134	133,942	12.03
Muskrat	101,044	116,201	1.15
Otter	386	6,080	15.75
Skunk	52	66	1.26
Wolf	701	6,134	8.75
Wolverine	123	673	5.47
Total	212,414	1,678,544	.....

The total value of the fur harvest from the Northwest Territories since 1922 exceeds $27,000,000.

MINING

Early Discoveries and Investigations

Over two hundred years ago it was reported that copper-bearing rocks existed near the north central coast of Canada, but it was not until the year 1771, when Samuel Hearne succeeded in reaching the river which he named the Coppermine, that he reported having seen native copper. However, the information he obtained was not sufficient to indicate the importance of the occurrence. The presence of burning beds of coal on the banks of the Mackenzie river near the present site of Norman was mentioned by Alexander Mackenzie on his return from his voyage of discovery in 1789. Sir John Franklin and other Arctic explorers reported the presence of native copper on the Coppermine river and on certain of the islands in the archipelago to the north. John Richardson, M.D., who was associated with Franklin in his overland expeditions, made the first study of the geology of the district and he described certain mineralized areas adjacent to Great Slave lake and in the Coppermine River valley.

For over a hundred years the Hudson's Bay Company secured a local supply of salt from beds that crystallized at the foot of a brine spring about 25 miles west of Fort Smith. Salt river, flowing by these springs and joining the Slave a few miles below this settlement, is so named because of the saline taste of its waters. Limestone has been burned for lime for many years in the vicinity of Good Hope.

In 1898, certain parties of gold seekers, who were attempting to reach Yukon Territory by way of the Liard or Mackenzie rivers, spent some time in prospecting in the vicinity of their camps. Although no important discoveries were reported, subsequent investigations have verified the correctness of certain of their observations as to the existence of mineral deposits, particularly in the Great Slave Lake area.

Oil and Gas

Oil seepages were observed for many years about 50 miles below Norman on Mackenzie river, and at Windy point on the north shore of Great Slave lake. In 1914 petroleum and natural gas locations were staked in both these areas but no boring operations were attempted for some years.

Between the years 1920 and 1925 drilling operations were undertaken in the Norman area by the Northwest Company (Imperial Oil Limited) and the Fort Norman Oil Company. The first mentioned company succeeded in "bringing in" two wells with an estimated production of 100 barrels daily in each case. Other wells drilled in this area were unsuccessful.

The Northwest Company also drilled a well in 1921-22 at Windy point, Great Slave lake. A depth of 1,806 feet was attained but no oil was discovered and the well was abandoned.

The White Beaver Oil Company drilled a well in 1922 in the vicinity of Hay River, about 15 miles south of Great Slave lake. A strong flow of salt water was struck and the well was abandoned at 715 feet.

In 1930, The Atlas Exploration Company, through their contractors Sudbury Diamond Drilling Company, carried out some diamond drilling on their locations situated fifteen miles from the mouth of the Hay river. Four shallow structure holes and two deep test holes were drilled, the latter reaching a depth of 766 and 781 feet, respectively. Salt water was struck in both the deep holes.

Lead-Zinc

Large lead-zinc deposits have been discovered on the south side of Great Slave lake in the vicinity of Pine point. A number of mineral claims have been staked and a considerable amount of development work performed thereon in recent years.

Pitchblende-Silver

Following the discovery of the pitchblende-silver deposits at LaBine point on the eastern shore of Great Bear lake in 1930, the area to the east and southeast, and to the north as far as Hunter bay, was actively prospected, with the result that further deposits, particularly of silver, were located and a number of claims were staked. Pitchblende deposits were discovered as far south as Hottah, Beaverlodge, and Hardisty lakes, approximately one hundred miles from the original discovery.

Cameron Bay, Great Bear Lake, Centre of a Rich Mineral Area

The property of Eldorado Gold Mines Limited at LaBine point has been brought into production, the company having installed a modern plant at the mine capable of handling approximately one hundred tons of ore a day. Pitchblende and silver concentrates are shipped to the company's refinery at Port Hope, Ontario, for treatment. Refining operations were commenced in May, 1933, and by November, 1936, the total production of radium amounted to one ounce, or 28 grammes. However, the capacity of the refinery is being greatly enlarged to allow the production of radium and uranium salts on a much larger scale. As the result of the establishment of this important industry in Canada, the price of radium has been reduced by more than one-half.

Bear Exploration and Radium Limited is also operating a mine at Contact lake, some eight miles southeast of LaBine point, from which silver concentrates have been shipped.

Gold

In recent years several discoveries of gold have been reported in the Great Slave Lake area. A large number of mineral claims have been staked for a distance of approximately three miles on each side of the Yellowknife river, extending up the river a distance of thirty miles from the head of Yellowknife bay. A number of mineral claims have also been staked on islands in Great Slave lake, notably Wilson and Outpost islands, and on the south shore of the lake, a few miles east of Taltson river. Active development is proceeding on certain properties on Yellowknife river and on Outpost island.

In the summer of 1936 a promising gold strike was made at Gordon lake, lying approximately fifty miles northeast of Yellowknife bay, and hundreds of claims were staked in this locality. A number of discoveries of free gold have been reported in the area and active prospecting operations are now under way.

Rumours of the existence of placer gold deposits in the South Nahanni River district have been current for many years, and the reported discovery in 1933 of the location from which the McLeod brothers are supposed to have secured gold some twenty-eight years previously, led to a small rush of prospectors to this area. A considerable number of placer claims have been staked on the several creeks tributary to the Caribou and Flat rivers, the latter of which flows into the South Nahanni about one hundred miles above the junction of that river and Liard river. While some representation work has been done on these claims the possibilities of the field are as yet unknown. Except by aeroplane, the area is very difficult of access. A few placer claims have been staked on Liard river, below Liard post.

Other Minerals

Outcrops of lignite occur in several places in the Mackenzie District, particularly along Mackenzie river and the southern and western shores of Great Bear lake. Locations under lease are situated twenty miles above Norman on the west bank of the Mackenzie, on the Peel channel approximately eleven miles north of Aklavik, and near Etacho point and McVicar arm on Great Bear lake. The location near Norman is being operated in a small way.

Development is in progress on a group of claims which were staked in 1932 on a nickel and cobalt-bearing mineral deposit situated a few miles east of the point where the Francois river enters the eastern arm of Great Slave lake. A deposit of nickel was also discovered some years ago on the north shore of Rankin inlet on the west coast of Hudson bay. A number of claims were staked but development has been suspended for the time being.

AGRICULTURE AND HORTICULTURE*

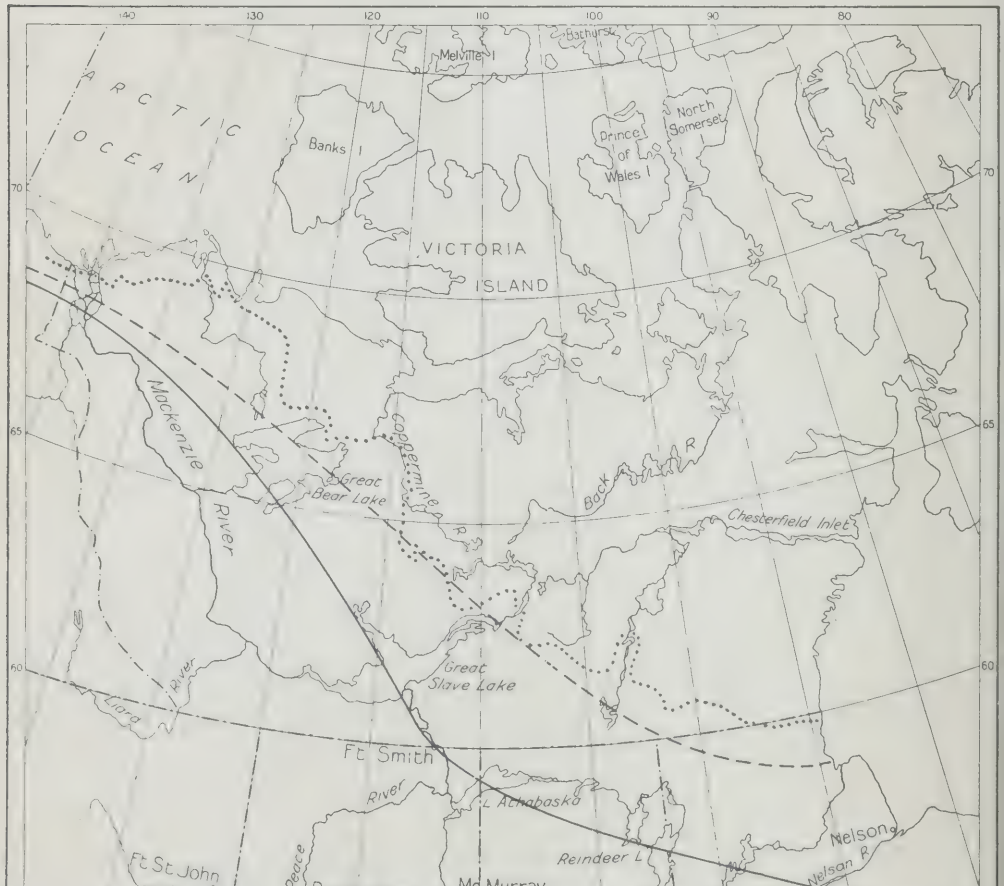
Farming and gardening in the Northwest Territories as a means of providing a livelihood for the resident population is admittedly of secondary importance. Although along the principal watercourses remarkable results in gardening have been obtained by both whites and natives, climatic handicaps would deny in the main to an agricultural community the scale of living normally enjoyed by Canadian farmers. Nevertheless, considerable grain and vegetable production is possible and the development of gardens continues to make life in the Territories more pleasant and profitable.

Sir Alexander Mackenzie, who in 1789 explored the great waterway which now bears his name, stated that, on the lower Athabaska river, Peter Pond had as fine a kitchen garden as he had ever seen in Canada. In the years that followed traders and missionaries planted vegetables at points much farther north. The Klondike gold rush contributed its quota of pioneers, but to the missionaries is due the credit for the extension of experiments in grain and

* By W. D. Albright, Superintendent, Experimental Substation, Beaverlodge, Alberta.

vegetable growing to such far northern points as Aklavik in the delta of Mackenzie river and Coppermine on the Arctic coast to the east.

Following the inauguration in 1908 of agricultural experimental work at Fort Vermilion on the lower Peace river, Alberta, arrangements were made by the Dominion Department of Agriculture for the undertaking of experimental work in 1911 by the Oblate Missions at Fort Smith, Providence, and Resolution, Northwest Territories. At Minto Creek, in Yukon, a substation ripened barley and oats successfully in 1915, and two years later, arrangements were made for conducting substation work on the farm of James Farr, at Swede Creek, Yukon Territory. Experimental work was inaugurated at Good Hope, N.W.T., in 1928.



Scale of Miles
0 50 100 200 300

Reference

Approximate northern limit of wooded areas.....

Line connecting some northern places where root crops have been grown successfully.....

Line connecting some northern places where wheat has been grown successfully.....

MAP OF NORTHERN CANADA SHOWING NORTHERN LIMIT OF SUCCESSFUL GROWTH OF WHEAT AND ROOT CROPS

In 1930 the writer was instructed to fly down the Mackenzie waterways system, making numerous calls en route, and to circumnavigate Great Slave lake on the return. The 4,015-mile aeroplane trip from McMurray, Alberta, north and back was made in planes provided by the Royal Canadian Air Force. During the journey which occupied from July 3 to 23, more than ninety interviews were obtained and were subsequently verified, 57 being with persons who had grown farm or garden crops from McMurray north. Through correspondence and co-operative experiment, touch has been maintained with quite a number of dwellers in Mackenzie District, while the annual reports of the substations have been synopsized. The author has also been privileged to peruse a report of Rév. Arthéme Dutilly, O.M.I., B.A., L.S.A., who in 1934 visited the Mackenzie and the Arctic coast.

The following are some of the pictures presented in a summary of the results of this investigation: horses thriving on the range along the Sixtieth parallel; crabapples ripening repeatedly beside Great Slave lake; potato vines at Simpson, 892 miles north of the International Boundary, growing an inch and a half a day and tomatoes ripening out-of-doors two years out of ten; winter eggs secured from domestic fowl at Providence and Simpson; vegetables and green feed grown on the edge of the Thelon Game Sanctuary (Lat. 63° N.); common wild fruits occurring almost to Arctic tidewater; potatoes and cabbages regularly planted at points down the Mackenzie almost to its mouth; garden produce grown in the Bear Lake mining field; rhubarb for table use, and cereals sufficiently mature to reproduce raised in the Mackenzie delta; and vegetables grown at Coppermine and Bernard Harbour on the Arctic coast.

These are indeed significant accomplishments in view of the frost hazard; the bleak winds; the drought danger; the brevity of the open season; the harass of mosquitoes and flies; the inclement winters; the length of the feeding period for live stock; the deficiency of winter sunshine and its effect upon animal physiology; the well-water problem; the danger of floods and landslides; and the transportation handicap. Admitting that the production reviewed has been secured along the shores of a great northward-flowing water system, the results are nevertheless surprising.

Cropping in the Mackenzie District will be essentially confined to the sedimentary lowland. Practically all the soils of agricultural value are believed to have been the product of alluvial deposit and water assortment. The arable area is conjectural and the area of reasonably dependable crop land much more so. Of the land from Simpson north the creek valleys would be found the best. Favoured gardens would be those with sharp southern slope and subsoil irrigation. There is much muskeg, but according to experience in the Athabaska and Peace valleys this is often capable of successful cultivation.

Moss peat is an important component of many northern soils. Decomposed and mixed with mineral particle, it appears to have beneficial effect as a soil ameliorant. After the fibre-destroying process of cultivation has proceeded too far some of the northern soils become "sad," as noted on certain of the older ground at Simpson, Providence, and Good Hope. The drained slough at Chipewyan, Alberta, on which the wheat that won the bronze medal at the Philadelphia Centennial Exhibition of 1876 was grown, had been carefully prepared after thorough burning. Later this proved an inferior piece of ground "on account of an excess of clay."

Back from the streams, much of the Mackenzie valley appears to have been repeatedly fireswept, lightning causing many outbreaks. Summer fires destroy humus so that large areas may be expected to represent a rather inferior class of woodland and brulé soil. Prevalence of blueberries doubtless denotes acidity. Aridity may be a major explanation of the observed tendency of wild barley to assert itself in abandoned clearings.

Horticulture seems more successful than agriculture, probably because the soil requires intensive fertilizing and cultivation, the latter to stimulate biochemical processes. Under prolonged cropping manure and legumes would doubtless be needed to maintain fertility.

Throughout a latitudinal spread of 944 miles from Lacombe, Alberta, to Good Hope, N.W.T., the July mean temperature was close to 60 degrees. The June mean declines a little toward the North; the May and August means decline more sharply. July is a month of rapid growth. In the Canadian North the summer isotherms swing sharply northwestward, longitude seeming to count as well as latitude.

Calculations made in 1933 showed that along Mackenzie river the four-summer-months precipitation ran about 6 inches down to Norman, but, beyond the Arctic Circle, it fell 4½ or 5 inches. Evaporation must diminish northward. Peat and frost conserve moisture. For a while after clearing, the scant summer precipitation is supplemented by the gradual release of frost-held water but after this has been exhausted within the reach of plant roots and capillarity, a modification of dry-farming methods may be called for.

Soil itself is radically modified by vegetative cover, and this by climate. Northern forested soils are subjected to a leaching process which affects their composition and structure. To what extent deep leaching may be restricted by permanent frost in the subsoil deserves attention. Within the soil as it occurs, nitrification and other vital processes that render plant food available are dependent upon the interaction of heat, air, and moisture. Particularly favourable physical conditions are required to release a sufficient annual quota from a poor soil. Steady cropping may therefore be expected to reduce most of the soils in question to a state of low productivity unless special attention be paid to the application of manures and to rotation with soil-improving legumes. That native legumes occur in the Arctic islands, and that others such as alfalfa, sweet clover, and alsike have shown a measure of promise at points far north is reassuring.

Forest and field crops grow above permanent frost. In Yakutsk, Siberia, agriculture is prosecuted above subsoil frozen to a depth of many hundred feet. In the mid-longitude of Eurasia, according to Constantin Nikiforoff, the region of perpetual frost reaches as far south as the 49th parallel of latitude.

Day length affects crops variously according to their specific habits. The potato responds favourably to a long day with a low temperature. Timothy blooms precociously in regions with great day lengths. In July, 1930, great willow herb (*Epilobium angustifolium*) and several grasses were further advanced along the Mackenzie than they were in the Peace River district on the same date, the season in the latter being rather backward that year.

The readings of self-registering minimum thermometers at Beaverlodge, Alberta, on an easterly slope with a rise of 134 feet in 214 rods have emphasized the effect of local elevation in escaping summer-night frost and winter low temperatures. The instrument at the foot once read 28° F. lower than a similar thermometer on the hill top. At the foot there is seldom a month that is free of frost while on the brow of the hill roses occasionally bloom until October.

Counteracting the susceptibility of low situations is the protective influence of open water, which in summer renders the river valleys safer than the plateaus though in winter the canyons may be the colder. Toward the tree-line, forest clothes the islands and borders the streams, doubtless indicating ecological factors that would affect cropping. On the other hand, the ice-cold water of the Arctic seas exercises a retarding influence, hence plant growth is better back from the littoral.

Nature carpets the boreal forest with moss. Whether man can in the long run enhance net production by clearing the forest and reducing the moss would require ages to decide. He can certainly increase insolation and swell immediate

production for human sustenance. At Hay River (Lat. 60° 52′ N.) permanent frost disappeared from the trench-drained garden surrounded with a clearing. At Thunder River (Lat. 67° 28′ N.) frost was found on July 13 at from 6 to 12 inches in the mossy forest but at 34 inches in the cultivated garden. At Aklavik (Lat. 68° 13′ N.) on July 11 the gauge went down 6 to 8 inches in the forest floor, 12 inches in sod burned over the first of June, and 24 inches in the potato patch. Pulverized, oxidized and mixed with mineral particle, the moss loses much of its insulating character. Solar heat striking the surface may then be absorbed and conducted downwards, while at night it may pass up in sufficient volume to prevent the surface air stratum from cooling below the killing point. There is strong evidence that clearing and cultivation affect ground and ground-surface temperatures, which in high latitudes are vital. Effect upon moisture conservation and windsweep are another matter.

Experienced frontiersmen agree that before any part of the North is opened for agriculture, conditions should be carefully studied and the most likely areas selected. If, then, settlement commences along the water front, working gradually back and utilizing the safer situations for the less hardy crops, frost will be fought with the best chances of success. Without dispossessing bison, reindeer, or musk-ox it may be feasible to introduce poultry and domestic quadrupeds, to grow field crops to some extent, and profitable gardens almost to the Arctic sea.

Field Notes on Individual Operations

Following are brief notes on the results secured in farming, gardening, and live stock production by organizations and individuals in the Mackenzie valley, ascertained by the writer in his trip down the Mackenzie in 1930 and his study of other data secured since that time.

Fort Smith.—Unlike most of the area to be considered, the site of Fort Smith is jack-pine sand, but heavy manuring induces luxuriant growth in most seasons. Westward along Salt River trail jack-pine trees give way to poplar, or alternates with it, and in places a passable type of woodland soil is observed. Root crops, including potatoes, turnips, and carrots are successfully grown in the vicinity of Fort Smith. On July 4, 1930, Garnet wheat at the Roman Catholic Oblate Mission near Fort Smith stood hip-high, afterwards ripening well. By 1935 Isidore Mercredi had met with some success in establishing apple and plum trees, seedlings surviving temperatures of —65°, protected only by snow. Four years previously the Mission had reported that crab-apple trees ten or twelve feet high tempted the youngsters with "an extraordinary number of small-sized fruits."

Great Slave Lake.—On the south shore of Great Slave lake spring is tardy but on the peninsular site occupied by the settlement of Resolution killing autumn frosts usually do not occur until September—in 1930 until the 27th. The Oblate Mission has a good garden, potatoes yielding as high as sixteen and a half bushels per bushel of seed. Celery and tomatoes are also grown. Excellent alfalfa and sweet clover plots have been raised at the Indian Agency and the Mission.

Two seedling apple trees several inches in trunk diameter, grown from pips planted about 1908, had been bearing since they were about ten years of age. In 1933 it was reported that 80 pounds of fruit was picked from two trees twelve feet high. These trees were later killed to the ground during a winter of very scant snowfall but the roots survived.

Hay River.—The soil at the trading post in the delta of the Hay river is eighteen inches of black silt loam overlying sand. The climate is described as rather windy and dry. At the Anglican Mission fine radishes grew in three weeks' time from a sowing in July. Caragana bushes were in full bloom on

July 6. The Mission's crop included potatoes, some good celery and green tomatoes. Fodder corn grew 3½ feet tall and small samples of grain graded as No. 2 Northern wheat, No. 2 Canada Western oats, and No. 2 Canada Western barley.

Rae and Artillery Lake.—At the tip of the north arm of Great Slave lake is Rae, where amid polished folds of granite the Oblate Mission made gardens by depositing rich soil found in crevices farther back. On July 17 potato plants almost covered the ground. Vegetables were excellent. Cultivated strawberries thrust up clusters of fruit through the leaves. A good crop of 14-ounce potatoes was dug on September 20. At Artillery lake, on the edge of the Thelon Game Sanctuary, lettuce and radishes were grown and oats and wheat headed but failed to fill.

Providence.—On the north bank of the west arm of Great Slave lake, a little below where it tapers into river proportions, is Providence (Lat. 61° 21′ N., Long. 117° 39′ W.). Gardening was begun here in 1867 and has been conducted since. Ripe tomatoes and celery are no novelties, and melons have been grown as large as apples. During five years the recorded potato return ranged from 5 bushels for 1 bushel planted to 15 to 1. Eggs have been obtained from domestic fowl in January.

A Mission Garden

Potatoes at Simpson planted on May 20. On July 7 plants measured 10¾ inches high. On July 17, when this photograph was taken, the staked plant measured 24 inches in height.

Simpson.—On a windswept alluvial island just below the confluence of the Mackenzie and the Liard is Simpson (Lat. 61° 52′ N.) where cropping has long been carried on and live stock kept. When there is warm, showery weather during the long midsummer days of this latitude growth is phenomenal. At the Oblate Mission green-sprouted potato sets had been planted on May 20. On July 7 a typical plant in an even, flourishing patch stood 10¾ inches above the mould. In a week's time its height was doubled and in August mealy tubers were being used.

Using artificial light, with a little heat during the coldest weather, and feeding a five-pound bottle of cod-liver oil, St. David's Anglican Mission, obtained eggs every month of the winter from 23 Rhode Island Red hens, the lowest production being 51 eggs in December and the highest 373 in April. A delphinium stalk blooming on July 17 measured seven feet, five inches. For the second time in ten years, tomatoes ripened in the Mission garden. White clover had wintered in a lawn seeding and caragana hedges were growing. The Indian Agency grew citron and pumpkin from open-sown seed.

In 1932 cereals made a fine showing and samples were displayed at the World's Grain Exhibition, Regina. Pickaninny and Squaw corn supplied roasting ears. The settlement's potato crop totalled 1,200 or 1,300 sacks. Plants surviving the winter of 1933-34 were asparagus, Iceland poppy, English daisy, pansy, Tartarian honeysuckle, cotoneaster, campion, chrysanthemum, Dalmatian toadflax, rocket, grass pink, sweet william, Reed canary grass, orchard grass, and winter rye. In 1935 corn, pumpkin, vegetable marrow, and squash came along with little trouble. One family had over sixty named varieties of flowers, many of them perennials.

The Lower Mackenzie.—At the mouth of the North Nahanni potatoes left unattended were found in the latter part of September untouched by frost, with a fine crop of large tubers. At Wrigley potatoes looked passable and were reported usually to produce fairly well. Wild sainfoin and fireweed were in bloom. At Norman a patch of potatoes averaged nearly six inches in vine height on July 10 and during the next five days grew an inch a day. Rank vegetation there included many species of wild fruits. In mid-July a stem of grass stood five feet tall, having made most of its growth in a month. Peas commenced to shell towards the middle of August. Beneath potato tops, unflattened when the crop was dug on September 12, were tubers the size of a double fist.

Great Bear Lake.—Vegetables were grown in 1931 on raw sand and clay at LaBine point, on Great Bear lake. The next year at Echo bay the Eldorado kitchen garden was about 60 feet square, built up with soil carried in sacks from various parts of the country. In 1934, a garden was laid out at Cameron Bay, the soil being transported to the south slope of a hill where planting took place in June when ice was still thick on the bay. Besides a small crop of potatoes Swiss chard, lettuce, radishes, broad beans, turnips, beets, and carrots were raised.

Good Hope.—Close to the Arctic Circle, Good Hope stands high and dry, with water on practically all sides. Potatoes have been grown at this post for two generations. In a luxuriant patch, blossoming vines were twenty inches tall on July 13. The yield was at the rate of 393 bushels per acre. The largest cabbages weighed twelve pounds. Timothy seeded May 21 appeared June 2 and was heading July 12. Early varieties of cereals were cut, rather green, between August 6 to 9, within 80 days of planting. Edible wild fruits noted were blueberry, pembina, cranberry, raspberry and excellent gooseberry. At The Ramparts, it was reported saskatoons had been growing there for fifty or sixty years, bearing heavily.

Thunder River.—Well within the Frigid Zone and 1,277 miles north of the 49th parallel a small stream called Thunder river enters the Mackenzie from the east. Two gardens were laid out here by W. D. Clark and measurement revealed 34 inches of thawed stratum in the garden, ten to twelve inches in unbroken land nearby, but only six to twelve inches in the adjacent thinly wooded muskeg. Potatoes planted in the gardens yielded 370 bushels per acre. Every cabbage headed, averaging eight pounds, with a maximum of 11½ pounds stripped. Barley and oats cut on August 10 made seed. Barley from the previous year's crop grew 34 inches tall and ripened August 14. Oats matured eleven days later.

Sunflowers seeded. Sweet clover grew four feet high. Alfalfa bloomed. Alsike clover made a fine stand two feet tall. Though there was too much rain in 1932 for grain to ripen fully, barley and oats made good samples, and were displayed the next year at the World's Grain Exhibition at Regina. In official opinion the Reward wheat appeared good enough to be graded No. 2 Northern; the Garnet wheat, No. 4 Northern; the O.A.C. 21 barley, No. 3 Canada Western; and the oats, No. 2 Canada Western.

A Northern Garden

Vegetable garden at Thunder River, 80 miles north of the Arctic Circle. Peas, 12 inches to 24 inches tall and podded. Beets, 7 inches to 9 inches. Carrots, 6 inches to 9 inches. Beans, 6 inches to 9 inches. Swedes, 8 inches to 18 inches. Cabbage, 6 inches to 8 inches with 21-inch spread of leaves. Oats, 30 inches and shooting. Potatoes, 7 inches to 10 inches. July 13, 1930.

In 1933 barley six feet tall was cut September 1, producing a No. 3 Canada Western sample. Oats, ripening September 7, made a No. 2 Canada Western. A grass crop sown May 26 cut about three tons of hay per acre. Plymouth Rock hens laid well.

Arctic Red River.—On a sharp slope at Arctic Red river (Lat. 67° 27′ N.) was a potato patch, planted June 4 and promising a yield. In the lower corner of the garden stood a bit of grain that had been planted May 17, and irrigated two days later by a flood caused by an ice jam at point Separation. By July 10 the wheat was two feet tall and in the shot blade. Vegetables did well; Blue-joint (*Calamagrostis*) and other grasses stood breast-high; fireweed was rank in purple bloom; and wild currants, gooseberries, and raspberries grew luxuriantly, some of them heavily laden.

Mackenzie Delta.—Aklavik (Lat. 68° 13′ N., Long. 135° W.) is roughly 1,330 miles north of the 49th parallel and some fifty miles south of Mackenzie bay. In 1926, when the Oblate Mission broke ground for a garden it was only six or eight inches to the frost, with moss above that. Potatoes grew the size of hen's eggs. Ten sacks of these potatoes were harvested and lettuce, radishes, carrots and flowers did well. Adjacent to the garden a rank crop of grass in full head was cut and cured for hay to be fed to a couple of steers. One stalk measured 3 feet 4½ inches. Collections included: *Poa fluitans* or *aquatica*, *Poa pratensis* or *trivialis*, *Beckmannia erucaeformis*, *Calamagrostis* sp., *Agropyron*

sp., *Senecio* sp., *Artemisia* (perhaps *elatior*), *Potentilla palustris*. Back from the clearing was a thick stand of spruce. Rose haws and fruiting currants were observed. Blueberry was said to occur and gooseberry to grow farther east. At a point about twelve miles south and three miles west of Aklavik, grain was sown in plots consisting of a foot of peaty loam underlain with a mixture of fine alluvial sand and clay. Small samples submitted were unofficially rated at Edmonton as follows: Legacy oats, No. 2 Feed, account green; Alaska oats, No. 1 Feed, account green; Lapland barley, No. 4 Canada Western, account green and frost. Garnet wheat heads were of good form and size, though the grain was immature. The samples attracted attention at the World's Grain Exhibition at Regina.

In 1935, before river break-up, plots were seeded to grain on May 26 on ground thawed only two or three inches. When harvested September 10 after a cold and backward season the oats and barley were rather green, and the wheat quite green.

Variety and Crop	Straw Length	Grade of Grain
	inches	Feed
Prelude Wheat	30	
Olli barley	25	No. 6 Canada Western
Peatland barley	32	No. 6 Canada Western
Cartier oats	28	No. 3 Feed
Legacy oats	24	No. 3 Feed

CONSERVATION OF GAME*

It is only within comparatively recent years that the problem of conserving the game resources of the Northwest Territories has become a matter requiring the serious attention of those responsible for the Government and administration of the Territories. The slow development of a crisis was undoubtedly due to the sparse human population scattered over an immense area and to the abounding wild life. Fortunately investigation was commenced and a measure of control effected in time, otherwise the story of the plains buffalo might have been repeated in the barren ground caribou, as it was to a large degree in the musk-ox, which are now reduced on the mainland to a few small herds within or comparatively close to the Thelon Game Sanctuary.

The need for control measures was brought about through the introduction of modern firearms by explorers, traders and trappers, and the change in the natives' views as to what constituted the necessities of life. In the normal course of events what happened was bound to happen, and for the purpose of this report it is considered sufficient to refer to the facts without discussing the reasons therefor.

To all intents and purposes the Indians and Eskimos of the Northwest Territories are still altogether dependent on game for their livelihood and the serious depletion of the wild life resources of the country would be a disaster from their standpoint. By nature and environment these natives must continue indefinitely as hunters and trappers. However, the matter is not important only to the natives. The fur trade of the Territories constitutes a not unimportant part of the Dominion's domestic and export trade, it is the base of supply of raw material for many Canadian industries, and it contributes considerable revenue to the federal treasury.

While appreciating the desirability of providing for the harvesting of the northern fur crop in an economic manner, the belief that the welfare of the native population is of paramount importance is reflected in many sections of the Northwest Game Regulations. The number of white trappers is restricted by a clause which limits eligibility for licences to British subjects who have resided in the Territories for at least four years. The quantity of game that may be taken is controlled by the regulation of the open and close seasons and in one case, that of beaver, by the fixing of a bag limit. Aircraft may not be used to enable the operation of trap-lines in different districts by one individual. Many large areas have been set aside as native game preserves and game sanctuaries. Trading may be carried on only at permanent establishments approved by the Administration.

Except in the case of those Indians whose superstitions disincline them to kill wolves, all hunters and trappers kill these predators whenever opportunity presents itself. It is expected that, in time, the superstitions of those Indian bands which hold this taboo will be removed through education. When wolf skins are fashionable the prices of the pelts are usually sufficient inducement for trappers to make a special effort to trap or shoot the animals during the

* The administration of the Northwest Game Act and Regulations comes under the Minister of Mines and Resources who is advised by the Northwest Territories Council. The direct supervision of administration is a responsibility of the Bureau of Northwest Territories and Yukon Affairs of the Department of Mines and Resources while enforcement of the regulations is carried out by the Royal Canadian Mounted Police who are *ex-officio* game officers under the Act. In Wood Buffalo Park a warden staff enforces the provisions of the game regulations applicable to the Park.

winter season. However, to encourage their destruction the Government pays a bounty on all wolves killed in the Northwest Territories.

The part played by wolves in the maintenance of nature's balance of wild life is realized, also the fact that when one of the factors controlling that balance is removed other influences are likely to be brought to bear to replace that which has been taken away. Under these circumstances it naturally follows that there is a limit beyond which it is difficult to secure beneficial results from the killing of wolves. However, even though the wolf population of the Northwest Territories can be kept only slightly below what is its normal level, that slight difference is of value because it costs a great deal in other game for even one wolf to maintain itself throughout the year. What is killed by wolves is of course not available to man, and moreover the destruction of game in traps by wolves means a further loss.

To keep abreast of game conditions in the Northwest Territories advantage is taken of all available sources of information. The collection of a tax on all pelts exported from the Territories enables a fairly accurate compilation to be made of the number and kinds of fur-bearing animals killed each year. This statement, considered in conjunction with the reports of previous years which indicate the cycles* of abundance and scarcity, portrays the status of the species. The local detachments of the Royal Canadian Mounted Police in the Northwest Territories supply reports periodically on game conditions in their respective districts. These reports are of great value. Questionnaires sent from time to time to trappers, traders and others, tap other sources of information. When occasion warrants special investigations are conducted by representatives of the Government.

CARIBOU

Although the caribou do not appear in the fur-export revenue statements, this species is of most importance in the economy of the Territories. As is rather well known the barren ground caribou migrate in a general southerly direction in the fall and a northerly direction in the spring but the forces which impel and control the movements of the herds are inadequately understood. The animals instinctively strive to reach their summer grazing grounds prior to the fawning season, usually towards the latter part of May. A number of reasons have been advanced for this inherited migratory instinct, namely, a desire to reach areas where there will be some slight relief from flies and other insects; an innate impulse that tends to prevent the too close cropping of any part of their grazing areas; an inborn desire to bring forth their young in localities where they will be less exposed to attack from predatory birds and mammals, and so forth. The routes followed are influenced by such factors as large bodies of water, and whether these are ice-covered or open; hunting by natives or whites, particularly when the leaders of the herds are shot down and the original course of migration thereby deflected; wolves; areas which have been burned over or otherwise denuded of fodder; ice encrusted snow through which the animals cannot break to get food; storms, and other severe weather conditions.

The former Department of the Interior initiated a wide inquiry in January, 1934, to secure all possible information regarding the migration of the caribou herds in the Northwest Territories. In reply to questionnaires many observers gave estimates of the numbers passing through their districts, but the figures supplied can only be regarded as approximate as it would be impossible to make an accurate count of large herds of caribou moving over a wide expanse of territory, and difficult to make even a close estimate.

* For a discussion of wild life cycles see "Canada's Eastern Arctic," pp. 62-66.

A preliminary study of the information obtained from these sources reveals that the summer range of the large caribou herds on the mainland includes the whole of Keewatin District, and the remainder of the mainland lying northward of a line running roughly from Wholdaia lake in southeastern Mackenzie District to Cameron bay on Great Bear lake. During the summer months the main caribou herds appear to congregate in the Back River and Burnside River districts to the northward of the Thelon Game Sanctuary and Yellowknife Game Preserve. In the fall they commence their southward journey. Unless disturbed they travel in small bands grazing en route. Occasionally they may appear as a solid mass such as when their migration is unaccountably diverted, when passing through a defile, or when avoiding difficult territory.

A general southward movement is usually apparent towards the latter part of September, and by October 15 the animals have reached the northern limit of wooded country from Fort Confidence on Great Bear lake to Dubawnt lake at the southeast corner of the Thelon Game Sanctuary. In 1933 they formed into three principal herds which proceeded to occupy the following areas for the winter season:—

(1) The district to the north of Great Slave lake and lac La Martre. A large herd occupied the greater portion of the available grazing area in the Yellowknife Game Preserve during the period November to April.
(2) The country west of Dubawnt river and east of Slave river between Great Slave lake and lake Athabaska. This herd probably comprised the greatest number of caribou in any given area at that season.
(3) In southern Keewatin District and northern Manitoba—widely scattered over the range.

In addition to the above a comparatively small herd ranged in the country to the west of Mackenzie river. The habitat of this herd appears to be partly in Yukon Territory and partly in the Northwest Territories, and ordinarily the herd is a source of food supply to the residents of Aklavik and McPherson districts.

There was a distinct shortage of caribou in the delta of Mackenzie river and also in the territory between Great Bear lake and the Arctic coast in 1933-34.

Caribou South of Richardson Bay, Great Slave Lake

In former years the caribou migrated through the latter district in immense numbers but in recent years the natives have experienced difficulty in securing sufficient meat and skins for their needs.

Information obtained from investigations made in 1935 shows that during the winter of 1934-35 the caribou passed through the country south and west of Rae which they had not visited for over twenty-five years. Another herd crossed to the west side of Slave river at a point between Salt river and Fort Smith. No barren ground caribou had been reported to the west of Slave river during the preceding thirty years. As in the previous year an exceptionally large herd wintered in the Yellowknife Game Preserve immediately north of Great Slave lake.

The migrations east of Slave river during 1934-35 differed greatly from those of the previous year. One herd wintered in the district immediately east of Slave river, north from lake Athabaska to Great Slave lake and as a consequence ample supplies of meat were obtained by residents of that area. Further east, in the district immediately north of the Province of Saskatchewan, caribou were so scarce that the native trappers were forced to move to another district in order to secure food. This was unusual as the area to the north of Saskatchewan is regarded generally as a good game country.

There was also considerable variation in the caribou migrations for 1935-36 as compared with recent years of which there is record. Caribou were reported very numerous during the summer and early fall months in the area east of Bathurst inlet including Kent peninsula. They were also numerous during that period in the Coppermine district. A few small herds remained in those districts throughout the winter but the main herd moved southward, passing through the Dubawnt River district during the months of September and October. They were also found throughout the westerly part of their range during the winter, but in smaller numbers than the previous year.

The small herd which ranges in the district to the west of Mackenzie river migrated south through the McPherson district during the winter of 1935-36.

Reports upon the caribou migrations of 1936-37 which have reached the Department of Mines and Resources to date mention a large migration southward past the east end of Great Slave lake during the months of December and January. Caribou entered the Wood Buffalo Park on the west side of Slave river where they remained from January to March, 1937.

REINDEER

With a view to broadening the basis of subsistence of the natives in Canada's Far North, the Dominion Government in 1919 appointed a Royal Commission to investigate the possibilities of the reindeer and musk-ox industries in the Arctic and sub-Arctic regions of Canada. In its report issued in 1922 the Commission recommended: "That small experimental reindeer herds be established in a number of such localities as may, after searching departmental investigation, be found most desirable in points of vegetation and otherwise."

In view of the development of the reindeer industry in Alaska, which as regards vegetation and climate somewhat resembles northern Canada, it seemed probable that suitable conditions might be found in parts of the Northwest Territories. It was, therefore, decided to undertake a careful examination by competent investigators of the territory bounded by the Alaska-Yukon boundary on the west, Coppermine river on the east, Great Bear lake on the south, and the Arctic coast on the north, to ascertain if the region contained suitable reindeer grazing areas. This part of the country formerly had been frequented by large herds of caribou.

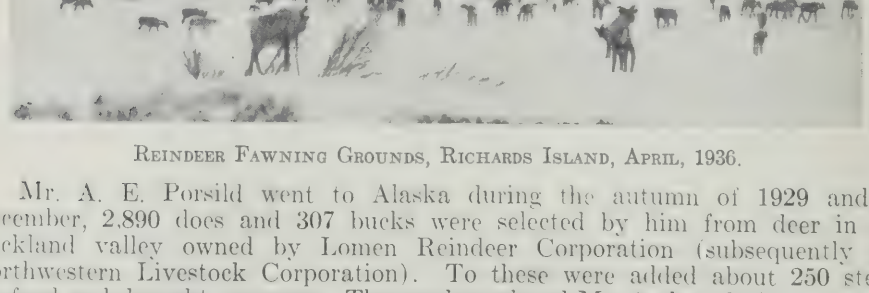
It was arranged that prior to commencing a general reconnaissance, with special reference to reindeer pasture and carrying capacity, the investigators

would, with the permission of the United States Government and the co-operation of its Bureau of Biological Survey, spend a season in Alaska studying the reindeer industry and its effect on the people of that country.

In April, 1926, A. E. Porsild, an experienced botanist, was appointed to conduct these investigations with the assistance of his brother, R. T. Porsild, both of whom had lived many years north of the Arctic circle and could speak the Eskimo language. The investigations occupied the period from May, 1926, to November, 1928, and thus included two winters and three summers in the field. During this time, in addition to steamboat and railway travel, an aggregate of 15,000 miles was traversed by dog-team, canoe, motor-boat, pack-dogs, and snowshoes. Extensive botanical collections were made whenever time and transportation permitted.

In his report Mr. A. E. Porsild, after recording his investigations of reindeer herds in Alaska and narrating his travels in the North, described a number of particular grazing areas that he considered suitable as reindeer pasture. These are (1) the coast of Mackenzie District and Yukon Territory (including Herschel island), west of Mackenzie river and east of the Yukon-Alaska boundary; (2) Mackenzie delta and islands; (3) the Arctic coast and hinterland from Mackenzie river to cape Bathurst; (4) the plains north of Great Bear lake; (5) Dease River valley, and (6) Dismal Lakes and Kendall River valleys.

Following the investigations and the publication of Mr. Porsild's report, negotiations were entered into with an Alaskan reindeer company for the purchase of a herd of 3,000 head of domesticated reindeer. The terms of the contract provided that delivery of the animals should be made by the vendors at a point on the Arctic coast east of Mackenzie River delta. The animals chosen for the drive were to be subject to the approval of a representative of the Department.



Reindeer Fawning Grounds, Richards Island, April, 1936.

Mr. A. E. Porsild went to Alaska during the autumn of 1929 and in December, 2,890 does and 307 bucks were selected by him from deer in the Buckland valley owned by Lomen Reindeer Corporation (subsequently the Northwestern Livestock Corporation). To these were added about 250 steers for food and draught purposes. The vendors placed Mr. Andrew Bahr, a veteran Lapp reindeer herder, in charge of the drive. Due to weather conditions, the presence of wolves and wild caribou, the stampeding of the reindeer, and other unforeseen circumstances, the drive took much longer than was anticipated. For more than five years the herd was on its long trek and it was not until March, 1935, that delivery was made of 2,370 animals in all, made up of 1,498 females of all ages; 289 bulls; 322 male fawns; and 261 steers. In the meantime corrals had been constructed; residences and other buildings required for the personnel

of the reindeer station had been erected; three Lapp herders and their families had been engaged and brought over from Norway, and a reindeer grazing reserve established by Order in Council. The reserve comprises an area of about 6,600 square miles and is located east of Mackenzie River delta. While this reserve was created as a grazing area for the reindeer herd it is also a game preserve. The important fur-bearing animal of the district is the fox.

The first fawning at the Government Reindeer Station took place in the spring of 1935. As a result 815 fawns were added to the herd bringing the total number—as shown by the August, 1935, round-up—to well over 3,000 animals. During the fall of 1935 a number of surplus steers were slaughtered and meat made available for the Mission hospitals and residential schools, relief, sale, or use at the reindeer station. The fawn increase as counted in August, 1936, was 936 head. The deer were grazed on Richards island during the summer of 1936 and moved back to the mainland in a healthy condition in the fall. At the August round-up, 3,750 deer were counted. A second slaughter was carried out to bring the number of male and female animals into a better balance and the meat disposed of as in the previous year. A preliminary estimate, made on May 6, 1937, showed a fawn increase for the year of 1,000 head.

The delivery of the herd has brought with it many problems which are in the process of solution, not the least of which is the difficulty of changing, comparatively rapidly, a hunting people to a pastoral people. Care is exercised in the selection of Eskimo youths to serve as apprentice reindeer herders.

MUSK-OX

Within comparatively recent times the musk-ox range extended over most of the Canadian mainland, east of Mackenzie river and north of the tree-line, as well as on many of the Arctic islands. On some of the more inaccessible islands their present numbers are probably still normal, on others they seem to have been all killed off. As a result of meeting the demand for hides in years past only a few small herds remain on the mainland.

In Thelon Game Sanctuary
Musk-oxen forming into a defensive circle, the cows and calves in the centre, the bulls facing outward.

The musk-ox is one of the hardiest animals known, being able to thrive on the dwarf willows, small herbage, and grasses that flourish in favoured localities in these regions, the herds in the winter time pawing away the snow to get at their food. Unlike the barren ground caribou, it does not migrate, other than retreating to sheltered regions during extremely severe winter weather, but prefers to remain in the same locality, grazing quietly like domestic cattle, and moving only as its pasturage becomes exhausted.

An average-sized, full-grown male musk-ox weighs from 550 to 600 pounds although it dresses much lower than might be expected. Its great covering of long hair and its formidable horns give it a more imposing appearance than actual size warrants, but it is quite agile and capable of defending itself against wolves. When alarmed a herd forms into a circle, or back to back, the adults facing the enemy and fighting savagely with their horns. This trait, however, makes the animals an easy prey to hunters.

The flesh of the musk-ox is very nutritious and compares favourably with beef at most seasons. Under its long hair, the animal has a closer covering of wool. This heavy coating of hair and wool, besides enabling the animal to maintain its body heat during winter, is thought to prove very effective in warding off the attacks of flies that cause the caribou great annoyance and injury during summer months.

It is claimed that the musk-ox can be domesticated readily. An experiment in this direction is being conducted by the United States Government in Alaska at the present time. Since its natural habitat is in the North, its preservation there and re-establishment numerically would constitute an asset which might be utilized in cases of emergency or to such extent as the surplus warranted, and in areas which could be put to no other economic use.

Data collected in recent years has not been sufficiently comprehensive or corroborative to justify a revision of the estimate of numbers which appeared in "Conserving Canada's Musk-Oxen," published by the Department of the Interior in 1930. This estimate is therefore reproduced with a map illustrating the former and present range of these animals in northern Canada. Colonel F. M. Steel, an officer of the Department of Mines and Resources, who accompanied an expedition conducted by Mr. Harry Snyder in 1935, reported that the expedition counted 172 musk-oxen during their two days' stay in the vicinity of Hanbury and Thelon rivers. This would seem to indicate that the estimate of 250 animals for the Thelon Game Sanctuary is now too low. On the other hand, a biologist, Dr. C. H. D. Clarke of the University of Toronto, who conducted a general reconnaissance of the sanctuary during the summer of 1936 for the National Museum, stated in a preliminary report that he and those associated with him had seen only 100 musk-oxen in the sanctuary and an additional 47 outside. Neither party was able to cover the whole sanctuary.

Under the Northwest Game Regulations the killing of musk-oxen is forbidden and the finding of skins of the animals in the possession of any person is taken as evidence of guilt. These restrictions apply to white persons and natives alike and are rigidly enforced by the Royal Canadian Mounted Police, who carefully investigate any reports of killing.

RESERVATIONS

Thelon Game Sanctuary—Native Game Preserves

In the interests of the native and other resident population of the Northwest Territories and for the purpose of safeguarding certain species of game needing special protection, large portions of the Northwest Territories have been set aside as preserves governed by regulations suited to their different conditions, namely:

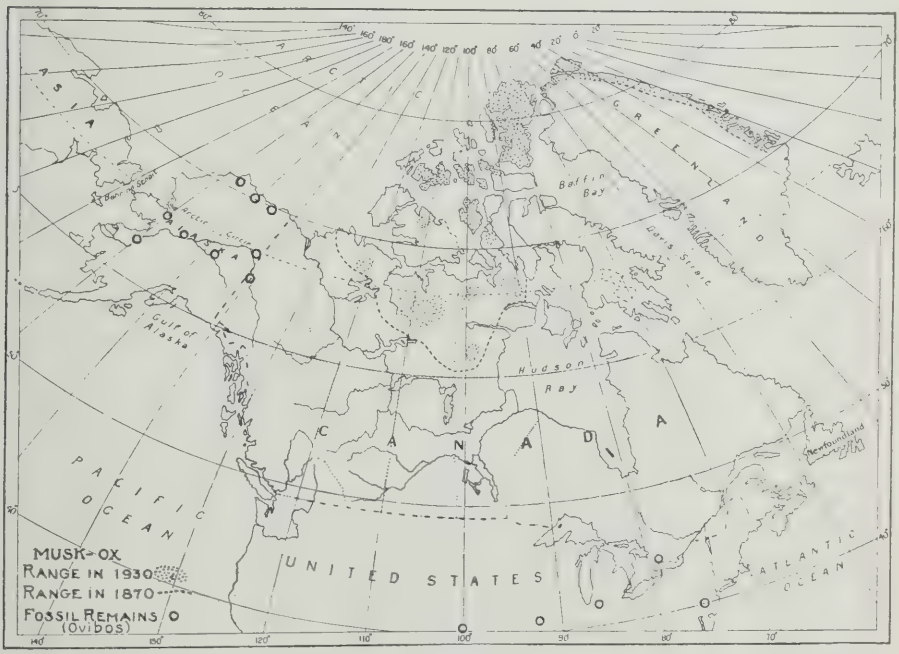
A. Those in which no one is permitted to hunt or trap.

B. Those in which only persons who hunted or trapped prior to the creation of the preserve (Park) are granted permits to hunt and trap therein.

C. Those in which, generally speaking, only native-born Indians, Eskimos and half-breeds leading the lives of natives are permitted to hunt and trap.

Of Class A there is but one such sanctuary—the Thelon Game Sanctuary. It was established by an Order in Council of June 15, 1927, becoming effective on September 1 of the same year. It embraces an area of approximately 15,000 square miles in the interior of the mainland of the Northwest Territories. The greater portion of the area is in the Mackenzie District but its easterly extremity lies in Keewatin District. In general terms it may be said to include the drainage basin of Thelon river north of the 63rd parallel of north latitude, and of its principal tributary, the Hanbury.

The preservation of the musk-ox was an important factor in the selection of this particular area, for the information obtained at the time indicated that in this vicinity was to be found the largest known herds surviving on the



The Range of the Musk-ox

Map showing distribution in 1930 as compared with that in 1870. *R. M. Anderson, 1930.*

Estimate of Numbers of Musk-oxen on Canadian Territory

Melville Island (based on evidence at Reindeer and Musk-ox Commission, etc.)		4,000
Ellesmere Island (based on reports of Sverdrup expedition, R.C.M.P. patrols and other explorers)		4,000
Axel Heiberg Island (east side only)		1,000
Devon Island (north side only)		200
Bathurst Island		1,500
Prince of Wales Island (reports by Major Burwash)		1,500
Cornwallis Island		200
Victoria Island		20
Banks Island (totally exterminated)		
Mainland:		
Thelon Game Sanctuary	250	
South of Adelaide peninsula to Perry river	50	
Murchison River region, from Committee bay to Rae strait and north of Wager bay	200	
North of Great Bear lake and west of Coronation gulf, perhaps 2 or 3 left		500
		12,920

mainland. However, small groups of musk-oxen have been reported elsewhere and it is quite possible that there are other unreported herds. It was also hoped that the setting aside of the sanctuary would assist materially in the conservation of the barren ground caribou. Before the area was finally reserved, information was sought and carefully studied as to the number of trappers that might be adversely affected, and the probability of the reserve attracting prospectors and others, as it was felt that only a complete reservation would fully serve the purpose in view.

The Northwest Game Regulations provide that no person (including Indians, Eskimos and half-breeds) shall enter the Thelon Game Sanctuary without special permission and such permission is granted only under exceptional circumstances. In providing a sanctuary for game, a wild life reservoir was created, the overflow of which, except as regards musk-ox, benefits those entitled to hunt and trap in the surrounding territory. With a view to obtaining more definite information as to the resources of the area a very considerable portion of the sanctuary was photographed from the air during the summer of 1936. Concurrently a biological reconnaissance was carried out under the direction of Dr. C. H. D. Clarke. Following the completion of the reconnaissance in 1937, the preparation of final reports, and the study of the information gathered during the survey, it can be decided whether an investigation in greater detail would be warranted.

Wood Buffalo Park, located partly in the Northwest Territories and partly in the Province of Alberta, is dealt with in some detail at the end of this chapter. It falls within Class B previously described.

Four native game preserves in Class C have been established in the Northwest Territories in which only native-born Indians, Eskimos, and half-breeds leading the lives of natives, may hunt or trap. Applications for permission to establish trading posts in these areas are very carefully scrutinized and permits granted only for locations deemed desirable from the standpoint of native welfare and conservation of game. These four preserves are as follows:—

Arctic Islands Preserve.—Area 439,105 square miles. This preserve, which takes in a portion of the mainland, embraces a large part of the fawning grounds and summer range of the barren ground caribou. The principal fur-bearer is the white fox which in normal years is very plentiful over the entire preserve. The establishment of trading posts is restricted at present to eight locations within this preserve, practically the whole of which is situated north of the Arctic Circle. A few white persons, representing missions, trading companies, and Government departments, reside in this preserve. The remainder of the population is composed of Eskimos.

Yellowknife Preserve.—Area 70,000 square miles. It is situated between Great Slave lake and Great Bear lake in the Mackenzie District and is almost entirely within the forested zone. The area yields many kinds of furs, chief among which are, fox, beaver, marten, mink, lynx, and muskrat. The central and easterly portions are prolific in game and are traversed by the barren ground caribou.

Slave River Preserve.—Area 2,152 square miles. It embraces the delta of Slave river and is situated south of Great Slave lake. It is the hunting ground of many of the Indian bands who reside on the south shore of Great Slake lake. The principal furs are coloured fox, beaver, lynx, marten, and muskrat.

Peel River Preserve.—Total area, 7,300 square miles. Area in Northwest Territories, 3,300 square miles. Area in Yukon Territory, 4,000 square miles. It embraces the mountain range of the Peel River area and comprises the hunting grounds of the Peel River and McPherson Indians. The principal furs are fox, marten, mink, and beaver. Big game such as bear, mountain sheep, and caribou, are comparatively plentiful in this district.

WOOD BUFFALO PARK*

Wood Buffalo Park, the largest big game preserve on the continent, embraces an unbroken wilderness area 176 miles in length and with an average width of nearly 100 miles—an area of 17,300 square miles. The establishment of the park was primarily for the protection of about 1,500 wood bison which were known to inhabit the area as originally established. Shortly after the park was created it was found that substantial numbers of bison were in the habit of crossing the Peace to forage in large natural hay meadows about Baril, Claire, and Egg lakes. In order to give protection to the buffalo in this area negotiations were concluded with the Province of Alberta in 1926 whereby the boundaries of the park were extended to include an additional 6,800 square miles between Peace river and Birch mountain bringing it up to its present area.

In Buffalo National Park at Wainwright, Alberta, the herd established there in 1908 had increased so rapidly the Department was faced with the necessity of reducing the herd in order to keep it within the grazing capacity of the park. As a measure to relieve the situation it was decided to transfer a number of the surplus animals to Wood Buffalo Park. This experiment was begun in 1925. During the next four years 6,673 buffalo were liberated in Wood Buffalo Park, comprising 4,826 yearlings, 1,515 two-year olds, and 332 three-year olds; for biological reasons, females made up the majority. After a necessary period of adjustment the Wainwright buffalo began to show an increase in size and vigour, accompanied by a darkening in the colour of hair, and of recent years have exhibited a pronounced and healthy increase.

IN WOOD BUFFALO PARK

View, at park headquarters (Government Hay Camp) looking northwardly along Slave river. The main buildings are immediately to the south. In this area there is a heavy spruce-poplar forest.

* Prepared by Mr. J. Dewey Soper of the Department of Mines and Resources who conducted a two-year investigation of conditions in Wood Buffalo Park.

The local administration of Wood Buffalo Park is in the hands of a Superintendent, who is also Departmental Agent, with residence at Fort Smith, N.W.T. Under his direction is the warden service of rangers with an intimate knowledge of park conditions. Warden cabins are situated at strategic points. Park headquarters are located at Government Hay Camp, on Slave river, 25 miles south of Fitzgerald. Over 100 miles of roads have been opened up through the park and in addition, about 200 miles of pack trails penetrate to more difficult sectors. When the area was set aside, Indians then resident there were permitted to retain their rights to hunt and trap, the only requirement being that they apply annually for a permit and observe the Park regulations. The number of these permittees is about 400.

Physical Features

Most of Wood Buffalo Park is within the Alberta plateau, with an average elevation of about 950 feet above the sea. To the west it is flanked by Caribou mountain, an erosion plateau of sedimentary rock, about 3,400 feet above sea level, and to the south, Birch mountain, of practically identical character, rises to a height of approximately 2,500 feet. Peace river intersects the southern part of the park to join the Slave-Rivière des Rochers drainage almost immediately north of Athabaska lake. Slave, Salt, and Little Buffalo rivers form the eastern boundary of the park to the mouth of the Nyarling. The latter river and the 34th base line constitute the northern boundary.

The mountains are substantially outside the park, but scenically dominate it, south and west. In the mountains originate a large number of rivers; the most important of those flowing into the park area being the Buffalo river in the north and Birch river in the south. One of the impressive curiosities of the park is the Nyarling river which completely disappears at intervals into strange

On the Summer Range of the Bison
The woods here are composed principally of Banksian pine and aspen poplar.

subterranean channels of natural limestone and gypsum. The Little Buffalo river is chiefly distinguished by its multiple falls just within the Northwest Territories where the last and largest of the series takes a sheer plunge of 40 feet. These are the only known falls of note within the park boundaries. Another peculiarity of the region exists in the Chenel des Quatre Fourches where, depending upon the fluctuating height of the water in Peace river and Athabaska lake, respectively, a reversing current develops at one time to the north and at another to the south. It is one of the rare instances in the world where this phenomenon occurs in fresh water.

The plain of the Alberta plateau is chiefly characterized by rolling, forested uplands broken by ponds, lakes, muskegs, and prairies. Considerable areas lack topographic relief of any moment, though isolated sectors are notable for outstanding sandy ridges of glacial origin. Many of these are 100 feet high and a few rise to more than 200 feet above the surrounding country. In general, they display a uniform trend in a northwest-southeast direction. The highest of those known at present occur in the Ninishith hills, where conspicuous buttes rise to 220 feet above the river. On the whole, this particular morainic system extends from near Brabant lake northwestward past Copp and Buffalo lakes and Buffalo river.

The eastern margin of the highland is bounded by a gypsiferous limestone escarpment along Salt and Little Buffalo rivers. To the south the borderline lies buried under morainic materials, reappearing, however, six miles east of Peace point on Peace river; from this point west to Bayer rapids the gypsum cliffs attain a maximum height of about 100 feet. The parts of the ramp to the north of Salt River loop appear as steep acclivities or sheer walls of moderate elevation centrally. Farther north the height is, in places, about 200 feet. The most conspicuous exposures border the Salt plain westwardly from Fort Smith. While most of this plateau is underlain with limestone-gypsum strata, rock outcrops are rarely seen. On the whole the area is poorly drained, with the result that in extensive sections there are many brackish sloughs and small lakes. Subsurface drainage is locally active through the solution of underlying rocks, which leads to a prolific development of sink-holes varying in size and form. Some are small, but the older holes are fully 100 feet in depth and many hundreds of yards in length. While numbers of the sink-holes are dry, many hold clear, deep water. Frequently these offer the only available supply of clear water within a wide radius.

Immediately west of the Slave River lowlands the country assumes a different character. The area is one of four distinct planes of elevation and has its western boundary at the foot of the Alberta Plateau escarpment. Generally speaking, it is flat and devoid of the profusion of sink-holes, morainic ridges, and lakes which typify the uplands farther west. While drainage is fair, streams are normally sluggish, with few rapids and no falls. The true salt plains west of Fort Smith lie at an elevation of 575 to 600 feet and drain to the north. Along the western margin, at the base of Salt Mountain escarpment, the noted salt springs emerge to combine in a single stream which flows to Salt river.

Southwards the plain rises imperceptibly to elevations between 700 and 800 feet above sea level to terminate at Peace river in a rolling sector frequently interrupted by fairly high, sandy ridges. Otherwise the greater part of the area is comparatively level, and in numerous places swampy. Dense forest covers most of the area, while the remainder is interspersed with grassy plains of considerable extent. These plains provide winter forage for the buffalo herds which move down in late fall from the summer range in the uplands farther west. Many of the small streams along the eastern border of this plain, which drain directly to Peace and Slave rivers and Murdock creek, are distinctly brackish, or strongly saline. Sulphur occurs at wide intervals. The most

notable sulphur springs, however, rise in the Alberta plateau. The best examples appear along the Little Buffalo and Buffalo rivers, where they tend to occur in local groups.

The lowest topographic area of the park comprises the alluvial lowlands bordering the chief waterways along the east side, and those surrounding Claire, Mamawi, Baril, and Egg lakes. The latter have a common level with lake Athabaska of 699 feet, normal. The adjacent land is mostly flat, elevated but little above ordinary lake level, swampy, and subject at times to floods. Enormous areas are covered with a luxuriant grass cover, while silty flats and hummocks support heavy growths of willows and other shrubs. Elevated tracts nearby carry stands of timber, the best of which is confined to the margins of the major streams in the Peace-Athabaska delta and elsewhere.

Random spurs of limestone occur along the upper Slave to vary the nature of the banks, while outliers of Precambrian bedrock appear in the same section. These are most notable about the west end of Athabaska lake, and over the sector traversed by Chenel des Quatre Fourches, Revillon Coupe, and Rivière des Rochers. The presence of these rocky hills radically alters the appearance of this territory in comparison with other sections of the park. While some of the rocky hills are wooded, the majority are either very sparsely covered, or absolutely barren, except for various mosses and lichens.

Flora and Fauna

Wood Buffalo Park may, for all practical purposes, be referred entirely to that vast transcontinental coniferous belt known as the Canadian Zone. On the south it is flanked by the Transition Zone, and on the north by the Hudsonian Zone, which in turn tapers by slow degrees into the cold and relatively barren sweep of the Arctic tundra.

Viewed in relation to the Temperate Region, the Canadian Zone, and consequently Wood Buffalo Park, lies in a high boreal plane. The north line of the Temperate Region is the limit of trees (i.e. the northern boundary of the Hudsonian Zone), and its south line the limit of frost. Throughout the park, faunal conditions are fairly uniform. This relative biological uniformity notwithstanding the distance between the southern and northern ends of the park is partly accounted for by a compensating decrease in altitude from south to north. It follows, however, that because of certain governing factors of dissemination, more species are to be found in the southern than in the northern park districts.

Recently the writer made a two-year faunal survey of the park which disclosed the fact that 46 species of mammals, and 216 species of birds have been recorded from the park, or immediate surroundings. Of the mammals, some are very rare in the park, and a large number of the birds occur only as migrants to and from Hudsonian and Arctic Zones. Regarded from the standpoint of noble proportions, the Bison is foremost and apart. Varying numbers of Bison have occupied this northern range since time immemorial. Late in the last century the total number was computed as low as 500; about 1920 this was placed at around 1,500, and at the present time, including the Wainwright transfers, the number is estimated at about 8,500 head. The great herds of these magnificent animals on the open plains offer one of the finest wild life spectacles in North America. Moose are common over the greater part of the area and notwithstanding the fact that several hundred are taken yearly for meat by the Indians, the number is believed to be increasing. Especially suitable areas are found in western and northern sectors, where Woodland Caribou also occur.

The number of Mule Deer is an interesting feature in view of the fact that until ten or twelve years ago the species was quite unknown in the park area. Since then Mule Deer have spread north of Peace river to and beyond the

northern boundary of the park, showing substantial gains. Black Bear are plentiful, as are many other species of fur-bearers, such as Fox, Lynx, Mink, Muskrat, Beaver, Weasel, Hare, and Skunk. Coyote and Timber Wolf are moderately common. Beaver have made a remarkable recovery under the supervision of the park officers. For a time they were completely protected, but as their numbers increased in many sections of the park, trapping by natives was again permitted, under quota during a restricted open season. Fox, Lynx, Marten, and Hare, exhibit, in particular, a natural periodicity of abundance and scarcity. Of late years Otter, Fisher, Marten, Porcupine, and Wolverine have been on the downward swing of their cycle. Cyclic periods vary in length, but that of the Snowshoe Hare, which is closely duplicated by the Lynx, covers a span of about 9 years.

Low Beaver Dam on Little Buffalo River
The central section of the dam has been partly carried away by spring floods.

Of the 46 species and sub-species of mammals inhabiting the area, six are represented by big game animals; one of these, the Barren Ground Caribou, reaches the park only irregularly in small numbers during the southerly mid-winter migration to the timber. Nineteen forms of fur-bearers occur, among the rarest being the Least Weasel and the Arctic White Fox; the latter is a more or less regular stray from the north during the colder months. Small rodents, including Woodchuck, Squirrel, Meadow and Red-backed Vole, Jumping Mouse, Deer Mouse, Chipmunk, animals of the genera *Phenacomys*, *Synaptomys*, etc., comprise at least 11 forms, while of the Shrew there are five species, and of the Bat not less than three.

Bird life is notably varied and abundant with a total record of 216 species and sub-species. A very large number of these consist of rather small and retiring forms which would not ordinarily attract the attention of casual travellers. This active host is made up mostly of the passerines, embracing such birds as the Thrush, Warbler, Flycatcher, Vireo, Chickadee, Wren, Lark,

Swallow, Waxwing, Finch, Blackbird, Tanager, Grosbeak, and Sparrow. Some of these are exceedingly abundant and enliven the summer woodlands with their songs.

The most conspicuous members of the avifauna are the water birds, including Loon, Grebe, Gull, Tern, Duck, Goose, and Swan, of which more than 50 species are represented. Of the various waders—the Sandpiper, Snipe, Turnstone, and Plover—together with Phalarope and Rail, at least 25 species are known in the park and vicinity, and Hawk, Eagle, and Owl reach a total of 20 species. The Sharp-tailed, Ruffed, and Spruce Grouse occur periodically in considerable numbers, while the Willow Ptarmigan is a regular and common winter migrant to the park. An analysis of the bird data for the territory gives the following ratio of occurrence for the various classes: permanent residents, 7·4 per cent; summer residents, 62·5 per cent; winter residents, 2·3 per cent; transient visitants, 15·8 per cent; and accidentals, 10·8 per cent.

The flora of the park is remarkable for its diversity. More or less dense forest covers the greater part of the area, the chief trees being white spruce, black spruce, tamarack, aspen, balsam poplar, white birch, and jack pine. As a zonal characteristic, coniferous trees predominate, imparting a decidedly boreal aspect to the scenery. The only deciduous trees of the region are the tamarack, birch, aspen, and balsam poplar. The finest stands of timber occur along the principal waterways where white spruce often attains a diameter of 18 to 24 inches, and the balsam poplar as much as 30 inches, both reaching a height, locally, of at least 80 feet. Although attractive stands are occasionally seen on the central highlands, growth there for the most part is much inferior.

In favoured sections, both on alluvial plain and fertile upland, the aspen commonly reaches a diameter of 15 to 20 inches, as a rule in rather open stands. Large sandy areas of the Alberta plateau are timbered almost exclusively with stands of jack pine, of park-like character, with a clean needle floor, where travelling is possible with the least difficulty. The species seldom attains notable size, but it is of better quality on gently rolling ground of moderate elevation than on the high morainic ridges, where it is often reduced to stunted form.

Of recent years the tamarack has been dying out in large numbers. Black spruce is chiefly confined to muskegs and other swampy localities. The most valuable species for various domestic purposes are white spruce, aspen, and white birch, though according to the writer's observations the latter is comparatively scarce. The rarest of the trees is the balsam fir, which was seen in but one locality—between Mamawi creek and Embarras river. A highly interesting occurrence is that of the lodgepole pine, recently reported at 2,000 feet and upwards on the east slope of Caribou mountain, often associated with black spruce. Though this particular locality is outside the park, the species will likely be found within it on the plateau farther north. Shrubs, grasses, mosses, and flowering plants occur in great profusion throughout the area. The whole subject has been dealt with recently by Dr. Hugh M. Raup.* It is the first elaborate treatment of the flora of the region. In Dr. Raup's summary of the plants there are 66 families; 211 genera; 449 species; 69 varieties and forms; while the number of different plants is 461.

*Bulletin No. 74—National Museum of Canada, 1935, pp. 174, pl. 13, maps and figs. 15, entitled, "Botanical Investigations in Wood Buffalo Park."

MAMMALS AND BIRDS*

Faunally, the region under discussion may be divided into two fairly distinct areas, (1) a more or less timbered area in the west and southwest falling within the Canadian and Hudsonian Life Zones, including the greater part of Mackenzie District, and a smaller proportion in the southwestern part of Keewatin District; and (2) a treeless or Arctic prairie region (the so-called "barren grounds") which is rather narrow in the northwest, nearly pinched out by the wooded Mackenzie River delta, and widening to the eastward and southeastward as it approaches the west coast of Hudson bay. West of Mackenzie River delta, the Arctic Life Zone widens out gradually to include the northern part of Yukon Territory, and becomes much more extensive on the north side of Brooks range in Arctic Alaska. A narrow fringe of Arctic-alpine conditions is found along the western border of the Northwest Territories, above timberline on the east slope of the Mackenzie mountains. Arctic-alpine conditions come gradually lower in higher latitudes, until they approach true Arctic Life Zone conditions near sea-level close to the Arctic coast.

The unusual uniformity of climate for several hundred miles and several degrees of latitude along Mackenzie River valley is largely due to the fact that in going "down North" increase in latitude is compensated for by decrease in altitude. When the Arctic coast is reached the altitude is uniform and local

Life Zones of North America
(Based on maps of Merriam, 1893, 1898; Merriam, Bailey, Nelson, and Preble, 1910; Brooks and Swarth, 1925; Seton, 1925); revised by Anderson, 1934.

* By Rudolph Martin Anderson, Chief, Division of Biology, National Museum of Canada, Department of Mines and Resources.

30968—7

climatic conditions are greatly influenced by winds blowing along the mountain ranges, from the pack ice or open water of the Arctic ocean, or from the stony barrens.

The Arctic Life Zone of course does not correspond with the astronomical or geographical Frigid Zone, which is bounded on the south by the Arctic Circle, whereas the Arctic Life Zone runs off below 60° North towards the shores of Hudson bay. The Arctic Life Zone in most parts is only barren in being devoid of trees, the stunted willows, dwarf birch, and alders which are found beyond the last stands of conifers, not being considered "trees" in the north, although some of them in more southern districts may approach the status of trees. Woody plants—Labrador tea, Lapland rose-bay, mountain cranberry, blueberry, and bearberry are found on suitable soils. The vegetal growth is slow, the plants being almost exclusively perennial. Some of the "bunch" type growing on dry or rocky ground include alpine poppy, cinquefoil, saxifrage, and various species of sedges and mosses. Other conspicuous Arctic plants growing on the tundra are buttercup, mountain avens, sorrel, smartweeds, lousewort, arnica, white heather, and cotton-grass, many species bearing brilliant flowers during the short summer.

In the Northwest Territories section of the Canadian Life Zone the predominating tree species are white spruce, jack pine, aspen poplar, balsam poplar, and white birch. The forests of the Hudsonian Life Zone are comparatively thin and scanty, and stunted in growth, the predominant tree being the white spruce, which may reach a good growth in thick stands. The forest growth, however, is not continuous, covering but a small fraction of the northern part of this zone, alternating with bare or lichen-covered rocks, sandy or grassy plains, and wet bogs or muskegs. Berry-producing shrubs are abundant, including blueberries, rock cranberries, raspberries, cloudberries, and bearberries. Many species of plants which occur on the northern tundra reach their greatest perfection in the bogs of the Hudsonian Zone, notably species of *Ledum* (Labrador tea), *Kalmia* (laurel), *Pedicularis* (lousewort), *Eriophorum* (cotton grass), and *Carex* (sedge). The flora of the Hudsonian Life Zone is remarkably uniform throughout, and is transitional in character, nearly every one of the species occurring either in the Arctic or Canadian zones.

Faunally as well as florally, the combined Canadian-Hudsonian Life Zone should properly not be considered Western Arctic at all, as the mammals and birds are essentially those of the northern temperate regions of Alberta, Saskatchewan, and Manitoba, with only an occasional species dropping out of the picture locally as the traveller goes north. Naturally there is more or less overlapping of zones in some sections, the musk-ox reaching its southern limit within the edge of the timber, and the woodland caribou meeting the smaller Barren Ground caribou in the same region. The bird fauna, which from its migratory character is not a perfect indicator of Life Zones, overlaps more regularly. The northernmost front of the Canadian zone species, the spruce grouse and sharp-tailed grouse, overlap the range of the willow and rock ptarmigan, and the tree sparrow and savannah sparrow meet the Lapland longspur and the snow bunting on their breeding grounds.

Mammals

A great mass of miscellaneous information on the mammal life of the Arctic regions is given in the accounts of the early explorers. Expeditions were often compelled to depend for food for long intervals upon the game of the country. The fur-bearing mammals were also the principal of the natural resources available in those times, when in popular parlance, the northern parts of British North America were known as "The Fur Countries." The same condition still applies in many districts where the Indians and Eskimos depend upon game and fish for most of their food, and fur is the only saleable crop with which

they can buy imported articles. While only a certain number of the mammal species are really marketable, the whole economy of the fur trade, and the very existence of the people in non-agricultural districts, is based upon the interlocking Balance of Nature.

The total number of species of mammals in the Northwest Territories is not very great, and most of the genera are circumpolar, although the white-footed mice (*Peromyscus*), wood-rats (*Neotoma*), lemming mice (*Synaptomys*), phenacomys, American porcupine (*Erethizon*), muskrats (*Ondatra*), and jumping mice (*Zapus*) are restricted to North America. Some of the older lists are rather vague in definition of species and cover too much territory to be useful for statistical purposes, but Preble (1908) listed 74 species of mammals in the whole of the Northwest Territories. Anderson (1913) published an annotated list including 45 species, 34 of which were definitely Arctic. Soper (see page 94), notes 46 species in the Canadian Life Zone of the Wood Buffalo Park, which includes a considerable area in northern Alberta. In the following list, an attempt is made to give some general information on the more important species, while all species known to occur are listed with mention of certain gaps in our knowledge.

Owing to the general high prices of fur, no collection in Canada has ever had an adequate representation of the fur-bearing mammals which form such an important part of our wild life resources. The fur-trade has known for years that examples of the same species from different parts of the country show marked differences in the texture of the fur, colours, and so forth, and are able to grade furs on this basis. Some species have been scientifically studied and comparative sizes and skeletal differences noted, but with many of the species we are still uncertain of the actual status of the geographical races, their distribution and abundance. Knowledge of breeding seasons, number of young, and other details of life histories are as a rule incomplete. The variations in numbers of young are of interest in considering problems of fluctuations in numbers of a species, recuperation after epidemics of disease, and other points of interest to fur-breeders and conservationists. In too many cases, it has been assumed that "everybody knows" certain things, but from the available records it is often found that nobody really knows certain apparently simple facts. Small detailed notes based upon careful observation may give important clues to scientific students, and it is hoped that future investigators will put more of their findings on record. The National Museum of Canada, so far as its facilities go, is endeavouring to collect scientific information of this type, and file it for the information of the public. The compilation of wild-life data requires team-work, as no one person can cover the whole country, or investigate every species personally, and some sights are perhaps seen only once in a lifetime.

SEA MAMMALS

The sea mammals are divided into two distinct groups: (1) The Cetacea (Whales and Porpoises), which are air-breathing mammals adapted to a strictly aquatic life; and (2) the Pinnipedia (Seals and Walruses), which derive their food from the water although they spend much time resting upon ice floes, rocks, or sandy beaches.

The number of species of sea mammals in the Western Arctic region of Canada is much smaller than in the Eastern Arctic. There are several reasons for this. Few of the Pacific species pass Bering strait, and between the strait and Beaufort sea the ocean is usually obstructed by pack-ice which interferes with the movements and feeding of some species. On the east the Canadian Arctic archipelago, with its many and tortuous channels which are blocked by ice during most of the year, forms a land and ice barrier which effectively prevents most of the Atlantic Coast species from reaching Western Arctic waters.

Cetacea (Whales and Porpoises)

1. Bowhead or Greenland Whale. *Balaena mysticetus* Linnaeus, 1758.

Type locality.—Greenland Seas.

The Bowhead Whale is the largest mammal of the Arctic regions, and in primitive times was perhaps the most important asset of the coast-living Eskimos. Bones of whales are found in old Eskimo village sites from Bering strait to Greenland, and, although whaling is practically an extinct art among the Western Canadian Eskimos, the old method of killing whales from skin-covered umiaks with hand lances was still practised east of the Mackenzie delta within the past fifty years. The pursuit of the Bowhead Whale by white men was begun in Spitsbergen and Greenland waters over 300 years ago, and as the whales became scarce the whalers sought other seas. In 1848 an American whaling ship passed through Bering strait into the Arctic ocean. The first whaling ship to venture east of point Barrow to Herschel island was the *Newport* in 1888. It returned west without wintering. The *Newport* and other ships lured by the new whaling grounds, came to winter in 1889, and by 1893 one-fourth of the vessels whaling in the North Pacific and Arctic spent the winter around the mouth of Mackenzie river. In 1894-1895 fifteen vessels, with about 800 men, wintered at Herschel island, Yukon Territory. Ships occasionally spent the winter at cape Bathurst and on two occasions as far east as Langton bay. As the ice in this part of the Arctic presses in close to the land and is never far away, the whaling season varied from six weeks to a maximum of three months for ships which wintered. During the latter years of the whaling business in the Western Arctic, whales were hunted chiefly for the baleen or "whalebone," and the oil and other products were largely disregarded. This was inherently an extravagant and wasteful exploitation of one of the few natural resources of the region, but with whalebone selling at $4 or $5 per pound, high profits might be made, in spite of lean years and casualties. Catches of 64, 67 and 69 whales per ship in a two-year voyage were recorded. The season of 1893 was the high year of the Western Arctic whaling fleet, with 309 whales taken. In addition to the whales captured by the ships, each captain usually obtained a few hundred pounds of bone in trade from shore-whaling Eskimos, as well as quantities of furs. The whaling industry in the Western Arctic lasted only about 25 years. One ship and one gasoline schooner, the only vessels which whaled in Beaufort sea, killed twelve whales apiece during the summer of 1912, but the voyages were considered unprofitable on account of the unsaleability of whalebone.

The short era of whaling was of great importance to the local Eskimos, who had previously little contact with white civilization. The whalers brought in numbers of Eskimos from western Alaska—Bering sea to point Barrow—to help man their whale-boats, and to hunt caribou and other game for the ships. This developed an interest among local Eskimos in trapping, which heretofore had been of little importance on account of lack of markets. The natives soon became well armed with modern firearms, and as the Alaskan Eskimos kept coming in numbers for many years, they gradually filled the gaps in population due to epidemics among the Mackenzie Delta and Liverpool Bay Eskimos, who were of a more sedentary type than the inland Western Eskimos.

The suspension of whaling operations for many years seems to be bringing the number of Bowheads up again to some extent and their future is assured until such time as the increase in numbers is sufficient to arouse commercial interest again. Fortunately for them, highly organized methods of pursuit are restricted by the difficult ice conditions and any great reduction in numbers of whales automatically renders whaling operations unprofitable. The most valuable use of this species of whale seems to be as a subsidiary food and fuel supply for the Eskimo people.

2. White Whale. *Delphinapterus leucas* (Pallas). 1776.

Type locality.—Mouth of the Obi river, Siberia.

The White Whale is found in Arctic and sub-Arctic seas in both the Old and New Worlds. In eastern North America it occurs from cape Cod, Massachusetts, as far north as Lancaster sound. In the west it comes into the mouth of Yukon river, and is seen frequently at point Barrow and as far east as Coronation gulf. The White Whale, commonly called "white fish," occurs generally in summer around the mouth of Mackenzie river. One of the best hunting-grounds is in the estuary of the Mackenzie, east of Richards island, where the whales appear in large schools in July, shortly after the ice breaks up. Another well-known hunting ground is at the north end of Richards island, and still another at the "Whitefish Station," between Tent island and Escape reef, Mackenzie bay. Some seasons as many as two hundred whales have been killed at one of these stations, but during other summers few are taken. The flesh and blubber are highly valued by the Eskimos, and the skin is prized locally for making boot-soles, rawhide thongs, and formerly for covering umiaks (skin boats). The ordinary method of hunting white whales in the shallow waters of this region is by pursuing them in whale-boats, striking first with the harpoon, and finishing the whale with a rifle-shot in the head.

3. Narwhal. *Monodon monoceros* Linnaeus. 1758.

The Narwhal appears more or less regularly in certain parts of the Eastern Arctic, including the northern waters of Hudson bay. It is of very rare occurrence in the point Barrow region, but its status in the Western Arctic region of Canada appears to rest upon Richardson's statement that spearheads and ice chisels made from the horn of this species were seen at Toker point, east of the mouth of the Mackenzie, in 1826, and that the Eskimos stated that the animal was found in the vicinity. Recent records are totally lacking in that region.

Pinnipedia (seals and Walruses)

4. Harbour Seal. *Phoca vitulina concolor* (DeKay). 1842.

The Harbour Seal occurs rarely in Hudson bay, but there are no authentic records from the Western Arctic region of Canada. The Pacific Harbour Seal, *Phoca richardii richardii* (Gray) is occasionally taken at point Barrow, Alaska, and may possibly work east occasionally into Canadian waters.

5. Ringed Seal. *Phoca hispida* Schreber. 1775.

The Ringed Seal is the most common seal and is generally found in most parts of the Arctic ocean, east and west. The Eskimos east of the Mackenzie formerly lived largely upon seals in winter, eating the flesh, and using the blubber for food, fuel, and light. The ordinary Eskimo *mukluk* or water boot is made of the skin of the Ringed Seal, usually with soles of Bearded Seal skin. The primitive Eskimos caught seals in nets or by spearing them at breathing holes, but the modern Eskimos usually shoot the seals with rifles, either in the water or on the ice.

6. Greenland Seal, Harp Seal. *Phoca groenlandica* Erxleben. 1777.

The Greenland Seal is common in the Eastern Arctic, including the northern part of Hudson bay. The only record from the Western Arctic region of Canada is a specimen caught in a fishnet at Aklavik, on the West channel of the Mackenzie in 1924. A photograph taken by Rev. Father Trocellier, O.M.I., shows a Harp Seal with characteristic markings.

7. Bearded Seal. *Erignathus barbatus* (Erxleben). 1777.

The Bearded Seal is a circumpolar species, but is more local in distribution than the Ringed Seal. It is seldom found far from shore, and seems to prefer shallow water. The Bearded Seal is occasionally taken around Herschel island and Baillie island, but is nowhere common west of Darnley bay. It reaches its greatest abundance in the region of Dolphin and Union strait, becoming less common in the Coronation Gulf and Banks Island region. The skin was formerly much prized for covering skin-boats, the skins of six or seven animals being needed for covering an umiak about thirty feet long. The skins are still in demand for boot-soles and for rawhide thongs. The Bearded Seal of Siberian and Alaskan waters has been described as *Erignathus barbatus nauticus* (Pallas), but comparison of a large number of specimens from Greenland to Western Alaska fails to show any consistent characters by which the subspecies can be separated.

8. Pacific Walrus. *Odobenus divergens* (Illiger). 1815.

MacFarlane (1905) states that walrus were formerly numerous between point Barrow and cape Bathurst, and that on several trips to Franklin bay from 1862 to 1865 he observed a few on the ice pack. Records from the northern Alaskan coast and east of the Mackenzie delta during recent years are rare and doubtful. One was killed at Herschel island in 1911, and one at King point, Yukon Territory, in October, 1914, and there is a hearsay record of one stranded in Dolphin and Union strait some years prior to 1914.

9. Atlantic Walrus. *Odobenus rosmarus* (Linnaeus). 1758.

The Atlantic Walrus comes into the northern part of Hudson bay and is common in Foxe channel up to Fury and Hecla strait, while in the north the western limit of its range is the upper part of Prince Regent inlet down to Bellot strait and the middle of Barrow strait south of Cornwallis island. Capt. Joseph F. Bernard stated that the Eskimos saw a walrus near the southeastern point of Victoria island about 1914, presumably of this species.

LAND MAMMALS

UNGULATA (HOOFED MAMMALS)

1. Mule Deer. *Odocoileus hemionus* (Rafinesque). 1817.

Within the past few years the Mule Deer has extended its range north of the 60th parallel in Wood Buffalo Park. C. E. Gillhaw reported one killed near Resolution in 1934, and Fred Camsell stated that they had been found near Simpson recently.

2. Moose. *Alces americana* (Clinton). 1822.

The Moose ranges north to the limit of trees, and occasionally a straggler wanders some distance north of the timbered country, both east and west of Mackenzie delta, near the mouth of Coppermine river, and northwest of Hudson bay. The Moose is most important to the Indians, the flesh being a principal article of food with some bands. The skin is generally used for moccasins and to some extent for hunting coats, but the leather is rather too thick and porous to make warm winter clothing. Moose are quite plentiful in the more favourable parts of their range, particularly in Wood Buffalo Park, and in some districts they are reported to be increasing in numbers.

3. Barren Ground Caribou. *Rangifer arcticus arcticus* (Richardson). 1829.

Type locality.—Fort Enterprise, Mackenzie district.

The Barren Ground Caribou was formerly generally distributed from the lower Mackenzie to Hudson bay, and is still the most important game mammal. No other skin is quite as comfortable for Arctic winter clothing, and many Indian and Eskimo groups depend upon caribou meat during long periods, particularly when they are hunting autumn skins for clothing or are on inland trapping expeditions. For many years caribou have been scarce near the Arctic coast west of Bathurst inlet, although considerable numbers are still found north and east of Great Bear lake. Within the past twenty years the Barren Ground Caribou have been more concentrated in the area between Bathurst inlet, Great Slave lake, and Baker lake, and during recent years have come much farther south than formerly, even crossing Slave river in small numbers into Wood Buffalo Park.

The appearance of caribou in districts where they were unknown before and the large herds frequently seen by air pilots have given rise to the belief that there has been a general increase in the caribou population, but the possession by the Central Eskimos of modern rifles and the change in their habits from winter seal-hunting to fur-trapping and caribou-hunting have probably resulted in a net decrease in the number of caribou over the Northwest Territories as a whole. The caribou of the northern islands are, on the average, smaller than those on the mainland, and apparently intergrade with the Polar Caribou, *Rangifer arcticus pearyi,* which are found in typical form on Ellesmere island.

4. Stone Caribou. *Rangifer arcticus stonei* Allen. 1901.

Type locality.—Kenai Peninsula, Alaska.

The caribou of the western side of the lower course of the Mackenzie river apparently belong to this form, according to study recently published by Murie (1935). The heavy timber along the Mackenzie river seems to act as a barrier to the movements of the Barren Ground Caribou, and the western form is on the average considerably larger than the Eastern form. West of the Mackenzie delta caribou were rare and uncertain for many years, but reappeared in numbers a few years ago, later falling off again in the region west of Aklavik.

5. Western Woodland Caribou. *Rangifer caribou sylvestris* (Richardson). 1829.

The Woodland Caribou is found sparingly in the wooded districts from northern Manitoba north to the Anderson river, overlapping the winter range of the Barren Ground Caribou to some extent. Large caribou are known to occur between Mackenzie river and the Mackenzie mountains west of Wrigley, perhaps belonging to this form, although Preble (1908) suggests that the caribou of the Nahanni mountains and other ranges of lower Liard river are probably referable to *Rangifer montanus* Seton-Thompson. The presence of *Rangifer arcticus osborni* Allen seems as plausible from geographical reasons, and specimens of caribou from this region are badly needed to settle the points in question.

6. Wood Bison. *Bison bison athabascae* Rhoads. 1898.

There is evidence that the Wood Buffalo formerly was found some little distance northwest of Great Slave lake as far as Horn mountains and Liard river, and for an indeterminate distance up the Peace River valley, and southward, but it is now restricted to the Wood Buffalo Park area, on both sides of the 60th parallel. The original stock was augmented by 6,673 Plains Buffalo from Buffalo National Park, Wainwright, in four annual shipments, and the total number of buffalo in the park was estimated at about 8,500 in 1934 (See section on Wood Buffalo Park, page 90.)

7. Musk-ox. *Ovibos moschatus moschatus* (Zimmermann). 1789.

Type locality.—Between Seal and Churchill rivers, Manitoba.

Within the past sixty years the Musk-ox ranged from Hudson bay northwest to the region of Liverpool bay, largely on the "barren grounds," although found in some numbers within the timbered edge of the Hudsonian Zone. The majority of the musk-oxen on the mainland of Canada are now restricted to the Thelon Game Sanctuary northeast of Great Slave lake, with a few scattered bands and individuals farther north. Few if any animals are known definitely to occur very near the Arctic coast.

8. White Mountain Sheep. *Ovis dalli dalli* Nelson. 1884.

In the Northwest Territories the White Mountain Sheep is restricted to the west of Mackenzie river, coming within a few miles of the Arctic coast south of Herschel island, and following the Mackenzie mountains as far south as Nahanni river, north of Liard river.

Carnivora (Flesh-Eaters)

9. Black Bear. *Ursus americanus americanus* Pallas. 1789.

The Black Bear is fairly common throughout the southern part of the wooded region, but becomes more rare towards the northern border of the Hudsonian Life Zone.

10. Macfarlane Bear. *Ursus macfarlani* Merriam. 1918.

A grizzly of the "*planiceps*-group," described from a specimen taken 50 miles below the site of old Fort Anderson, and which has also been taken on Horton river, and as far east as Stapylton bay, Dolphin and Union strait.

About ninety species and sub-species of grizzly and big brown bears have been described from North America, some of them from rather scanty material, and their distribution has not been well worked out. As four of the five forms referred to the Northwest Territories come under different "groups" of these bears as separated by Merriam (1918) it is fairly certain that at least four of them can be accepted with assurance. Much additional material is needed for scientific records before these bears are all gone. As many of the grizzly bears were described from skulls alone, the skins are needed to show the character of hair and claws. For the same reason it is frequently almost impossible to identify a grizzly bear skin without the accompanying skull.

11. Anderson Bear. *Ursus andersoni* Merriam. 1918.

A grizzly of the "*hylodromus*-group," known only from the type locality, east branch of Dease river, east of Great Bear lake.

12. Barren Ground Bear. *Ursus richardsoni* Swainson. 1838.

This species as well as the following one belongs to the "*richardsoni*-group" (Barren Ground Grizzlies). The original type specimen was taken by Dr. John Richardson near the mouth of Hood river, Bathurst inlet, and the National Museum has a specimen taken at the type locality in 1915 by a party of the Canadian Arctic Expedition of 1913-18. The species is not known to occur east of Kent peninsula, and it has been taken nearly as far west as Mackenzie river, being perhaps most abundant in the Horton River region south of Franklin bay and east to Coppermine river.

13. Mackenzie Delta Grizzly. *Ursus russelli* Merriam. 1914.

Known definitely only from the Mackenzie delta (Russell, 1898) but bears from farther up the river and on both sides of the delta may belong to this form. The Alaska Boundary Grizzly, *Ursus internationalis* Merriam, 1914, was described from a specimen taken by H. F. Lambart of Ottawa on the Alaska-Yukon

boundary, about 50 miles south of the Arctic coast. Two or three specimens have been taken west of the boundary, and there is no barrier preventing it ranging freely to the western edge of the Mackenzie delta.

14. Macfarlane Yellow Bear. *Ursus inopinatus* Merriam. 1918.

Type locality.—Rendezvous lake, northeast of old Fort Anderson, Mackenzie District.

Certain peculiarities in dentition of the type specimen caused Dr. Merriam to put this bear in a new genus (*Vetularctos*). While there are occasional reports of "yellow" or "white" bears apparently answering the description of this species from as far south as the north side of Great Slave lake, this rare bear has very seldom been taken and very little is actually known about it. Merriam (1918) provisionally referred to Thickset Grizzly (*Ursus crassus* Merriam) one skull of grizzly from Anderson river and two from Horton river and Langton bay on the basis of some dental peculiarities. The type locality of the latter species is Upper Macmillan river, Yukon Territory, and its status in the Northwest Territories is still "provisional."

15. Polar Bear. *Ursus maritimus* (Phipps). 1774.

The Polar Bear is much less common on the mainland coast of Beaufort sea (except in the region of cape Bathurst and cape Parry) than it is west of point Barrow. It is very rare in the Coronation Gulf region, becoming more plentiful from Victoria strait eastwards. The Polar Bear usually keeps to sea ice but is sometimes stranded temporarily if the ice drifts away in summer. It seldom wanders far inland, but Dr. Charles Camsell reports meeting a large polar bear on August 4, 1900, on the southeast side of Teshierpi river, northeast of Great Bear lake, about 75 miles from the nearest salt water.

Marten

16. Hudson Bay Marten. *Martes americana abieticola* Preble. 1902.

This is apparently the marten found in timber within the Hudson Bay drainage system, but the range is not well defined.

17. Alaska Marten. *Martes actuosa* Osgood. 1900.

Found in greatly fluctuating numbers in the more heavily wooded areas of Canadian and Hudsonian Zones in the Arctic drainage, but becoming rare towards the edge of the "barren grounds."

18. Fisher. *Martes pennanti pennanti* (Erxleben). 1777.

One of the rarest and most valuable fur-bearers, it is found chiefly in heavily forested parts of the Canadian Life Zone. It occurs only rarely in southwestern part of Northwest Territories (Slave river, Simpson, Liard river).

19. Richardson Weasel. *Mustela cicognanii richardsonii* Bonaparte. 1838.

Type locality.—Fort Franklin, Great Bear Lake.

This medium-sized weasel is common in wooded sections as far north as Great Bear lake, and is rather important as a source of ermine skins. In the northern part of the Hudsonian Zone and the Arctic Zone it is replaced by the Tundra Weasel.

20. Least Weasel, Mouse Weasel. *Mustela rixosa rixosa* (Bangs). 1896.

This tiny weasel, known by its small size, and short tail without black tip, occurs as far north as Keele river and Norman. The Alaskan Least Weasel, *M. r. eskimo* (Stone) has been taken on the Arctic coast of Alaska, but the writer was never able to find any trace of this form east of the International Boundary.

21. Western Arctic Weasel. *Mustela arctica arctica* (Merriam). 1896.

Type locality.—Point Barrow, Alaska.

Generally distributed but not very common along the Arctic coast; more common within the northern part of the Hudsonian Zone.

22. Eastern Arctic Weasel. *Mustela arctica semplei* Sutton and Hamilton. 1932.

Type locality.—Coral inlet, Southampton island.

Degerbøl (1935), working with a large series of weasels from various parts of Arctic Canada and northern Europe, described a new subspecies as White-lipped Arctic Weasel, *Mustela arctica labiata*, with type locality Malugsitaq, Melville peninsula, and stated to occur on all parts of Baffin island, intergrading with *M. a. artica* in the region of Kent peninsula and King William island. By the law of priority *M. a. labiata* will have to be regarded as merely a synonym of *M. a. semplei*.

23. Keewatin Mink. *Mustela vison lacustris* (Preble). 1902.

Occurs from Great Bear lake and western shores of Hudson bay southward through northern Alberta, Saskatchewan, and Manitoba.

24. Alaska Mink. *Mustela vison ingens* (Osgood). 1900.

Type locality.—Fort Yukon, Alaska.

Common in wooded parts of northwestern Mackenzie, at least as far south as Good Hope and east to Anderson river.

25. Wolverine. *Gulo luscus luscus* (Linnaeus). 1766.

Found locally throughout the wooded regions, and frequently ranging far beyond the timber; recorded as far north as Pond inlet, Victoria island, and Melville island. More common in the region east of Great Bear lake than in

any other district visited by the writer. The fur is much prized by the Western Eskimos as edging for parka hoods, as frost does not readily adhere to the guard hairs.

26. Mackenzie Otter. *Lutra canadensis preblei* Goldman. 1936.

Type locality.—McTavish Bay, Great Bear lake.

North to Mackenzie delta; fairly common at the west end of Great Bear lake, and occasionally taken at the east end of the lake.

27. Northern Plains Skunk. *Mephitis mephitis hudsonica* Richardson. 1829.

The Skunk is fairly common in the Wood Buffalo Park region, and has occasionally been taken as far north as Simpson on the Mackenzie.

28. British Columbia Red Fox. *Vulpes fulva abietorum* Merriam. 1900.

Type locality.—Stuart lake, British Columbia.

The "coloured" foxes (red, cross, silver, and black) of the region north to Great Slave lake are referred to this subspecies.

29. Alaska Red Fox. *Vulpes fulva alascensis* Merriam. 1900.

Type locality.—Andreafski, near mouth of Yukon river, Alaska.

This very large, richly-coloured fox is the form found from Great Slave lake northward, mostly in the timbered or partially timbered regions, although in the Coronation Gulf region it was fairly common during winter of 1915-16 on the coast one hundred miles or more from timber.

30. White Fox, Blue Fox. *Alopex lagopus innuitus* Merriam. 1902.

Generally distributed on Arctic coast and islands; very abundant in some localities at the height of the four-year cycle, which is followed by a great scarcity of foxes. At the height of the cycle large numbers of White Fox may move south as far as the northern parts of Saskatchewan and Manitoba. The blue phase is much rarer in the Central Arctic region than in Greenland, Eastern Arctic, or Western Alaska.

31. Northern Coyote. *Canis latrans latrans* Say. 1823.

32. Mountain Coyote. *Canis latrans lestes* Merriam. 1897.

33. Northwestern Coyote. *Canis latrans incolatus* Hall. 1934.

The status of the coyote in the Northwest Territories is uncertain. It is generally claimed that coyotes have increased within recent years, and the assumption is that the big Northern Coyote, *C. l. latrans*, known also as brush wolf, has worked north through Manitoba and Saskatchewan, and that the Mountain Coyote, *C. l. lestes*, has moved north along the Rocky Mountain foot-hills and adjacent regions. The description of a new northwestern form, ranging in northern British Columbia, Yukon, central Alaska, and lower Mackenzie, seems to show that coyotes were probably indigenous in parts of the region and modern conditions have been such as to allow them to spread out and occupy new territory.

34. Northern Timber Wolf. *Canis lupus occidentalis* Richardson. 1829.

The original type locality was given as Canada from the plains of the Saskatchewan to the Arctic coast, but the name has been restricted to the form occurring at Simpson, Mackenzie District.

This large timber wolf is generally distributed in the wooded districts where large game is abundant, but is most abundant towards the edge of the "barren grounds"; intergrading with *C. l. tundrarum* in the region north and east of Great Bear lake, and probably also to the southeastward of this region.

35. Tundra Wolf. *Canis lupus tundrarum* Miller. 1912.

Type locality.—Point Barrow, Alaska.

The Tundra Wolf averages smaller than the timber wolf of the sub-Arctic, and the coat is paler in colour, although not more than thirty per cent of the specimens can be called white or creamy in colour. A much larger number are buffy or tawny, with blackish hairs along the back. The writer has seen skins of dusky and black wolves from Arctic Alaska, Coronation Gulf, Great Bear Lake, and Thelon River regions.

Pocock (1935) has placed all the circumpolar wolves as subspecies of *Canis lupus* Linnaeus (type locality, Sweden), and described a skin and skull from cape York, Greenland, as a new subspecies, *Canis lupus orion*, and a skull from Melville island as *Canis lupus arctos*, either of which may perhaps be found later to include wolves from some of the other Arctic islands.

36. Canada Lynx. *Lynx canadensis canadensis* Kerr. 1792.

The Canada Lynx is an important fur-bearer, usually confined to the wooded regions, living largely on Snowshoe Rabbits. The year following the periodic disappearance of rabbits, approximately every nine or ten years, the lynx wander far beyond their normal range, even north to point Barrow and the Arctic coast of Canada.

Canada Lynx

Rodentia (Gnawing Animals)

37. Canada Woodchuck. *Marmota monax canadensis* (Erxleben). 1777.

The Canada Woodchuck is found in suitable situations along the Slave and Mackenzie rivers as far north as Simpson, and some distance up Liard river, probably intergrading with *M. m. ochracea* in the upper Liard region.

38. Northern Hoary Marmot. *Marmota caligata caligata* (Eschscholtz). 1829.

The Northern Hoary Marmot or "whistler" occurs in the spurs of the Mackenzie mountains at least as far north as the Arctic Circle. The writer has seen skins from the Endicott mountains west of the Alaska-Yukon Boundary, and probably the species occurs in the mountains west of the Mackenzie delta. Howell (1915) provisionally refers two skins from Liard river in extreme southwestern Mackenzie to *M. c. oxytona* Hollister, Robson Hoary Marmot. More specimens are needed for scientific study from the northern parts of the range of this animal, which is often erroneously called "badger" by white traders (Anderson, 1934).

39. Parry Ground Squirrel. *Citellus parryii parryii* (Richardson). 1825.

The type locality of this species is Lyon inlet, Melville peninsula, and it is found locally in favourable areas of the "barren grounds" from Hudson bay to Alaska, avoiding hard, stony ground and favouring areas where dry, friable, or sandy soil is available for burrowing. The skin of the Arctic Ground Squirrel is sometimes used for making light parkas where other skins are not available, and the flesh is much used by some of the Eskimos, particularly in early spring or on summer hunting trips.

40. Lake Bennett Ground Squirrel. *Citellus plesius plesius* Osgood. 1900.

Preble (1908) refers specimens from mountains west of the Mackenzie river, near Norman, and from Liard river, to this species.

41. Northern Chipmunk. *Eutamias minimus borealis* (Allen). 1877.

The Northern Chipmunk occurs along Slave and Mackenzie rivers as far north as Simpson and Liard posts.

42. Yukon Chipmunk. *Eutamias minimus caniceps* Osgood. 1900.

The Yukon or Grey-headed Chipmunk is most abundant in southern Yukon Territory and northern British Columbia, but has been taken in the Nahanni mountains. The northern limits are imperfectly known.

43. Hudson Bay Red Squirrel. *Tamiasciurus hudsonicus hudsonicus* (Erxleben). 1777.

Type locality.—Severn river, Hudson bay, Ontario.

This red squirrel is found in the timbered areas in Hudson Bay drainage, ranging south to northeastern Minnesota.

44. Mackenzie Red Squirrel. *Tamiasciurus hudsonicus preblei* Howell. 1936.

Type locality.—Simpson, Mackenzie District.

This newly described subspecies occurs in wooded districts, chiefly in the Athabaska-Mackenzie valley system and the greater part of central Alaska, south to North Saskatchewan river, Saskatchewan. It is found north to the Mackenzie delta and the east end of Great Bear lake. This squirrel is paler in colour and considerably larger than typical *hudsonicus*.

45. Hudson Bay Flying Squirrel. *Glaucomys sabrinus sabrinus* (Shaw). 1801.

Ranges in wooded districts from lower Churchill river north to Simpson on Mackenzie river, and possibly Anderson river; rare in most localities and difficult to find in the northern woods.

46. Canada Beaver. *Castor canadensis canadensis* Kuhl. 1828.

The beaver was formerly common nearly to the northern limit of trees in the Mackenzie delta. About ten years ago it was found necessary to establish a close season for these animals to prevent undue depletion of the supply. They are now fairly plentiful in many of the more suitable districts of the Northwest

Territories and in Wood Buffalo Park. It would appear that the animal is steadily increasing under the existing regulations, which allow male residents to take a limit of fifteen beaver each year.

47. Northern White-Footed Mouse. *Peromyscus maniculatus borealis* Mearns. 1890.

Type locality.—Simpson, N.W.T.

This species is generally abundant as far north as Norman. Occurrences are rare farther north, and odd records at Good Hope and other posts are perhaps accidental, as the writer obtained a specimen at Herschel island which came ashore from a transport barge of the Hudson's Bay Company from Mackenzie river, August 6, 1914.

48. Drummond Wood-rat. *Neotoma cinerea drummondii* (Richardson). 1828.

The Drummond Wood-rat or "pack-rat" reaches its northern limit in the Liard River valley, with one record each from Liard post and Fort Halkett.

49. Richardson Lemming Mouse. *Synaptomys borealis borealis* (Richardson). 1828.

This little, broad-headed vole with short, stubby tail has been taken from northern Alberta to as far north as Great Bear lake and Rae on the north arm of Great Slave lake, but is not usually very common anywhere.

50. Alaska Brown Lemming. *Lemmus trimucronatus alascensis* Merriam. 1885.

Type locality.—Point Barrow, Alaska.

This lemming ranges from northwestern Alaska to the west side of Mackenzie delta, averaging much brighter reddish than the race found east of the Mackenzie. The writer took a specimen at Herschel island, August 2, 1908, and at various points farther west. The brown lemming has been reported as coming out on the sea ice in large numbers at point Barrow in 1887, and the late Archdeacon Stuck of Alaska told of hundreds drowning while trying to cross Yukon river. This lemming is apparently the same as the Yukon Lemming, *L. yukonensis* Merriam, 1900, type locality, Charlie creek, Yukon river, Alaska, the alleged differences being due to comparing specimens in different pelages. The difference is certainly no more than subspecific in any case.

51. Back Lemming. *Lemmus trimucronatus trimucronatus* (Richardson). 1825.

Type locality.—Point lake, upper Coppermine river, Mackenzie District.

This brown lemming averages darker and duller in colour than the western form, and is found on the "barren grounds" from the eastern edge of Mackenzie delta (Toker point) to Hudson bay, and south to Artillery lake and Thelon river. It also occurs on the southern parts of Banks and Victoria islands, and north to Pond inlet, northern Baffin island. There are few records of big migrations of lemmings in North America comparable to the well-known migrations in northern Europe, partly because there are fewer observers in Arctic Canada, and the Canadian Arctic is generally comparatively flat and does not give opportunities for concentration in settled regions at the base of the mountains as in Norway, Sweden, Finland, and Russia. The brown lemmings do not change colour in winter.

52. Alaska Collared Lemming, Fork-Clawed Lemming, White Lemming. *Dicrostonyx groenlandicus rubricatus* (Richardson). 1839.

This lemming ranges along the northern Alaska coast and eastward to Coronation gulf, including southern Banks and Victoria islands, intergrading east of that region with *D. g. richardsoni*. A common belief among the Eskimos is that the White Lemmings fall from the sky in winter, and they have also noted that in winter the cleft fore claws look like the hoofs of caribou. The

explanation is that the lemmings work under the snow all winter and the claws are developed for digging, and they are seldom seen in winter except when a blizzard removes the snow above their runways. In summer most of the natives do not distinguish the lemmings from other mice, although the mottled coat with narrow blackish dorsal stripe is characteristic of this genus in summer coat. Lemmings have a periodic cycle of abundance about every four years, and the following period of scarcity is usually marked by a poor year for White Foxes.

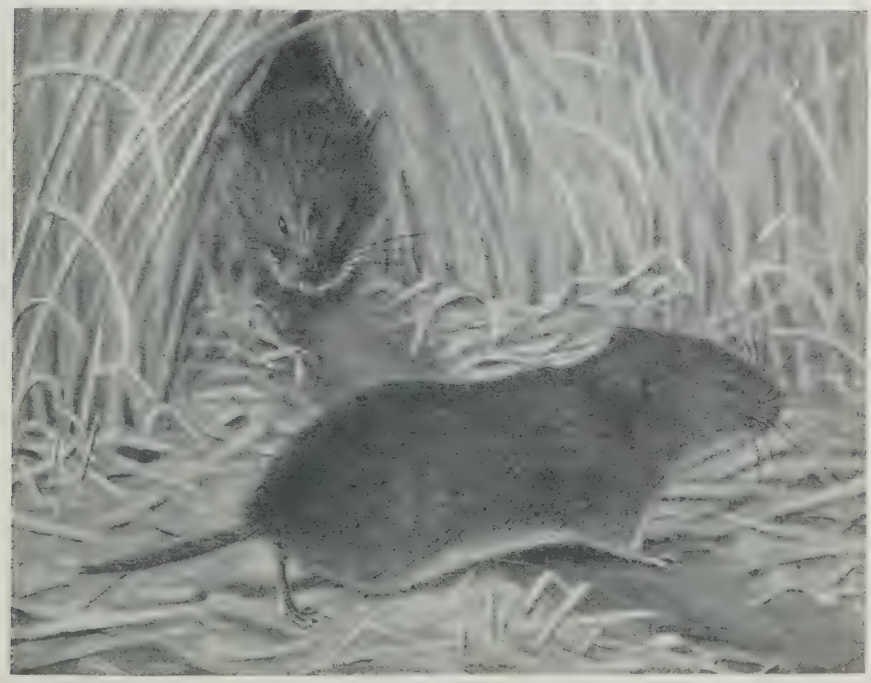
53. Richardson Collared Lemming. *Dicrostonyx groenlandicus richardsoni* Merriam. 1900.

This subspecies is noticeably duller in colour than the western subspecies —dull brown to greyish and reddish reduced to a rusty tinge—and is found on the "barren grounds" from Bathurst inlet to Hudson bay, and southward to the edge of the Hudsonian Life Zone (Thelon Game Sanctuary and adjacent areas). Careful study of numerous specimens from the mainland and the Arctic islands convinced the writer several years ago that this form intergrades with *D. g. groenlandicus* Traill on the southern islands of the Canadian Arctic archipelago north of Keewatin District.

54. Mackenzie Phenacomys. *Phenacomys mackenzii* Preble. 1902.

Type locality.—Fort Smith, Slave river, N.W.T.

This rare little vole, sometimes called "false lemming mouse," has been taken near Churchill, Manitoba, in northern Saskatchewan, in northern Alberta, and at a few points in the Northwest Territories (Fort Smith, Resolution, and lake Saint Croix, northwest of Rae). It may be known by its short tail, yellowish face, and whitish feet.



Meadow Mouse

55. Athabaska Red-backed Mouse. *Clethrionomys gapperi athabascae* (Preble). 1908.

Type locality.—Fort Smith, N.W.T.

Common in northern Alberta, and along Slave river north to Great Slave lake.

56. Dawson Red-backed Mouse. *Clethrionomys dawsoni dawsoni* (Merriam). 1888.

Named for the late Dr. G. M. Dawson of the Geological Survey of Canada, who took the type specimen on Finlayson river, Yukon Territory.

This species is considerably brighter in colour than the Athabaska species. It ranges from the north side of Great Slave lake to the limit of trees, frequently beyond the tree-line. The writer took three specimens at Port Epworth on the south shore of Coronation gulf many miles from timber, and one specimen at Teller, Alaska, on the shore of Bering sea.

57. Drummond Meadow Mouse. *Microtus pennsylvanicus drummondii* (Audubon and Bachman). 1854.

Ranges from Hudson bay to central British Columbia, and from the United States boundary north to the limit of trees. This vole fluctuates greatly in numbers during a cycle of about four years, and during periods of excessive abundance may be a pest in agricultural districts. In the northern parts of its range it forms an important part of the food of foxes and other carnivorous fur-bearers.

58. Barren Ground Meadow Mouse. *Microtus pennsylvanicus aphorodemus* Preble. 1902.

Type locality.—"Barren grounds" about 50 miles south of Eskimo point, near the mouth of Thlewiaza river, District of Keewatin.

This vole intergrades with *M. p. drummondii* in Churchill region, but the limits of its range are unknown, as little systematic collecting of small mammals has been done in interior parts of Keewatin District. Like all the small rodents it undoubtedly plays a part corresponding to its numbers, forming a portion of the essential food supply of fur-bearing mammals.

59. Macfarlane Tundra Mouse. *Microtus operarius macfarlani* Merriam. 1900.

Type locality.—Old Fort Anderson, Anderson river, Mackenzie District.

This tundra mouse was originally described as a distinct species, *Microtus macfarlani*, in honour of the veteran naturalist, Roderick MacFarlane, former chief factor of the Hudson's Bay Company, who did much pioneer work on mammals in the North, and who collected the first known specimens of this vole. The writer collected extensive series of tundra mice in northern Alaska as well as east of the Mackenzie, and has for several years listed the Mackenzie form as entitled to no more than subspecific rank. Mr. Raymond C. Gilmour, who has recently been working on mammals of the Bering Strait region at the Museum of Comparative Zoology, Cambridge, Mass., has examined nearly all of the available specimens of the "*operarius*-group" of tundra mice, including specimens in the National Museum of Canada, and he informs the writer that *macfarlani* is really indistinguishable from the Yukon Tundra Mouse, *M. o. enderocus* Osgood, 1909, the type of which came from Charlie creek, Yukon river, Alaska. That being the case, the name *macfarlani* has nine years priority over *enderocus*, and the MacFarlane Tundra Mouse may be taken as the form inhabiting central Yukon and central Alaska. The tundra mice are of considerable interest as being the most eastern representatives of a group common in eastern Siberia and western Alaska. Canadian specimens are available from Lapierre House, Old Crow river, Firth river, Aklavik, Tuktoyaktuk, and Toker

point (east side of Mackenzie delta), Anderson river, Franklin bay, and Langton bay. The most eastern records known are a large series from Langton bay, where the species was common in runways in beach grass (*Elymus*) and in the old whalers' house. The tundra mouse is often abundant and is a prey of the Arctic fox. The western Eskimos often gather quantities of the vegetable food stored in the mouse burrows on the tundra. Further investigation of the voles and mice found on the "barren grounds" south and east of the Franklin Bay region may show that this species has a much wider range than now known.

60. Chestnut-cheeked Meadow Mouse. *Microtus xanthognathus* (Leach). 1815.

Type locality.—Hudson bay.

This large, handsome vole occurs locally from central Alberta north to the Arctic coast and west to central Alaska. It seems to be distributed very locally and subject to violent fluctuations in numbers, as trapping over wide areas may fail to locate colonies, and later collectors have not been able to find a single specimen in spots where they were abundant in previous years.

61. Hudson Bay Muskrat. *Ondatra zibethica alba* (Sabine). 1823.

Type locality.—Cumberland House, Saskatchewan.

This muskrat is found in waters draining into Hudson bay from the west and which arise in northern Manitoba, northern Saskatchewan, and Keewatin District north to the limit of trees. The scientific name is something of a misnomer, as the animal is really not as pale as the Great Plains Muskrat (*O. z. cinnamomina* Hollister), the name *alba* being due to the fact that the type specimen was an abnormally pale or faded specimen.

Muskrat

62. Northwest Muskrat. *Ondatra zibethica spatulata* (Osgood). 1910.

Type locality.—Lake Marsh, Yukon Territory.

The Northwest Muskrat inhabits all suitable streams, ponds, and marshy areas in the Mackenzie River drainage of the Northwest Territories, north to Richards island in the Mackenzie delta and on lower Anderson river. It is not very common in the lakes of the rocky districts bordering the "barren grounds" and the rats in such areas are more apt to live in holes in banks instead of building houses. The best muskrat areas in the Northwest Territories are in Slave River delta and Mackenzie River delta, but many smaller marshy areas also produce large crops of rats, which form an important part of the fur returns in those districts.

63. Hudson Bay Jumping Mouse. *Zapus hudsonius hudsonius* (Zimmermann). 1780.

Type locality.—Hudson bay.

This beautiful and graceful jumping mouse occurs from the Maritime Provinces west to northern Alberta, and in the Northwest Territories has been recorded from Fort Smith, Resolution, Simpson and Rae. The most northern record is a specimen found dead by the writer at the edge of the Indian village at Norman, July 6, 1908.

64. Canada Porcupine. *Erethizon dorsatum dorsatum* (Linnaeus). 1788.

Type locality.—Eastern Canada.

The Canadian porcupines are rather variable in appearance, and the records of species are not well differentiated. The eastern form, *dorsatum*, which has the guard hairs mostly black, is listed by Preble (1908) as occurring in nearly all areas throughout the forested region, but rare, as it is considered a desirable food animal by the Indians, and easy to capture. It is not now known to native Eskimos east of the Mackenzie except by hearsay, although MacFarlane (1905) reported porcupines ranging in the northern part of Anderson River region

65. Yellow-haired Porcupine. *Erethizon epixanthum epixanthum* Brandt. 1835.

The writer was with a party of Eskimos during the winter of 1908-09 who found, killed, and ate three porcupines in the Endicott mountains (Brooks range), west of the Alaskan boundary, and information was obtained about one killed on Hula-hula river before that time, as well as one at Ice Reef, Alaska. They are frequently seen on Firth river, near Herschel island. Preble (1908) states that the Yellow-haired Porcupine appears to be confined mainly to the region of the Rocky mountains. This should probably be taken to include the Mackenzie mountains.

Lagomorpha (Hares)

66. Hudson Bay Arctic Hare. *Lepus arcticus labradorius* Miller. 1891.

Type locality.—Fort Chimo, Ungava bay, Quebec.

The Arctic Hare of the west side of Hudson bay was described as *Lepus arcticus canus* Preble, 1902, with type from Hubbart point, Keewatin District. Later researches by the late E. W. Nelson (1934) and by A. H. Howell (1936) show that the Ungava Hare is found on both sides of Hudson bay as well as on the southern half of Baffin island. Data is lacking to show how far this subspecies ranges west of Hudson bay. The Hudson Bay form is smaller than the Barren Ground subspecies, paler in summer coat, and with much less black on the ears at all seasons.

67. Barren Ground Hare. *Lepus arcticus andersoni* Nelson. 1934.

Type locality.—Cape Barrow, Coronation gulf, Mackenzie District.

The Barren Ground Hare is larger than either *arcticus* or *labradorius*. Its summer coat is a rather dark blackish-grey, with much black on the ears. It ranges over a wide territory from the western edge of Hudson Bay drainage, coming some distance within the scantily timbered area along the northern edge of the Hudsonian Life Zone, west to Great Slave lake and Great Bear lake and to the Arctic coast. It occurs on the Arctic coast only as far west as the southern part of Franklin bay, but occurs inland, rarely, to the eastern side of the Mackenzie delta. This hare also occurs on southern parts of Victoria island and Banks island; very rare in the western parts of its range, preferring rough, rocky land. It is a shy animal and is seldom seen even where tracks give evidence of its presence. The hare's winter coat of white is protective in that season and the summer coat from early June but, as the hares begin to assume the winter coat before the end of August, they are sometimes conspicuous on the brown tundra if the first snowfall comes late.

68. American Varying Hare. Snowshoe Rabbit. *Lepus americanus americanus* Erxleben. 1777.

Type locality.—Hudson bay.

This hare is found in wooded portions of southern Keewatin and southeastern Mackenzie Districts, northern Ontario, and northern Quebec, and most of the northern parts of Manitoba, Saskatchewan, and Alberta, intergrading with *L. a. macfarlani* in the Slave River region. It is very important as food for many Indian tribes, and one of the largest sources of food for many of the valuable fur-bearing mammals, particularly the lynx and fox.

69. Mackenzie Varying Hare. Snowshoe Rabbit. *Lepus americanus macfarlani* Merriam. 1900.

Type locality.—Old Fort Anderson, near the mouth of Anderson river, Mackenzie District.

The Mackenzie Snowshoe Rabbit is somewhat larger than the eastern form, and averages more greyish in colour, but the colour differences are not very great. It is generally distributed in the Mackenzie District as far as the northern limit of trees in Mackenzie River delta, Anderson river and Horton river. According to statistics compiled by Elton from the records of the Hudson's Bay Company most of the hares die off periodically, the cycle averaging about 9·6 years.

From personal experiences of the writer, rabbits were not common in Mackenzie delta in 1908, and only a few scattered tracks were seen in the mountains farther west during the winter of 1908-9. During the winter of 1909-10, rabbits were abundant in the delta and numbers were seen on low delta islands in the summer of 1910, also enormous numbers of willows had been barked above snowline during the preceding winter and spring. Early in the spring of 1914 rabbits were from time to time found dead in large numbers on the west branch of the Mackenzie. Rabbits were so abundant near the northern limit of trees on lower Horton river a few years before this that they were taken out in sledge-loads, but during the years 1909 to 1912, which the writer spent in the region, only two or three were seen altogether, although a diligent hunt was made to get specimens. During several years no rabbits were observed along the coast east of Franklin bay. Rabbits form an excellent addition to a balance ration, but the flesh is not very nourishing as a "straight meat" diet. Some of the Indians make excellent, warm sleeping robes by weaving strips of rabbit skin in a loose mesh, covered with light cloth for protection.

Insectivora (Shrews)

70. Cinereous Long-tailed Shrew. *Sorex cinereus cinereus* Kerr. 1792.
Type locality.—Fort Severn, Hudson bay, Ontario.

This species is very widely distributed, from Nova Scotia to northern Alaska, reaching the Arctic coast in Mackenzie delta, Liverpool bay, and Coronation gulf.

71. American Saddle-backed Shrew. *Sorex arcticus arcticus* Kerr. 1792.
Type locality.—Fort Severn, Hudson bay, Ontario.

The Saddle-backed Shrew, formerly known as *Sorex richardsonii*, is rather rare in the Northwest Territories, but has been taken as far north as Rae and Norman. This species and the following may be distinguished by the tri-coloured back, with dark longitudinal dorsal band.

72. Tundra Saddle-backed Shrew. *Sorex tundrarum* Merriam. 1900.

This species is largely Alaskan in distribution, but has been taken on Peel river, Toker point, and lower Anderson river. While shrews are not common in the Eskimo country, the natives are suspicious of them, alleging that they sometimes gnaw holes in skin "pokes" containing seal-oil or whale-oil.

73. Dusky Shrew. *Sorex obscurus obscurus* Merriam. 1895.

This mountain species ranges from New Mexico to Alaska, but in the Northwest Territories has only been recorded from the extreme southwestern portion (Resolution, Simpson, Nahanni mountains).

74. Richardson Water Shrew. *Sorex palustris palustris* Richardson. 1828.
Type locality.—Marshy places from Hudson bay to the Rocky mountains.

This species has been recorded as far north as Wood Buffalo Park, Simpson, and Grandin river, north of Great Slave lake.

75. Northwestern Pigmy Shrew. *Microsorex hoyi intervectus* Jackson. 1925.

This representative of the smallest species of mammal known in North America has been recorded from Fort Smith, Resolution, Rae, Simpson, and the site of old Fort Franklin at the west end of Great Bear lake. The Pigmy Shrew is probably more common than the records show, but the adult is apt to be taken for a young Cinereous Shrew. The writer was informed that shrews (species unknown) were sometimes abundant enough in the vicinity of Norman to do damage in storehouses by gnawing into animal substances, such as bacon, skins and fur. In more southern districts shrews have recently been shown to destroy large numbers of larvae of spruce sawfly and other insects and grubs which are injurious to forests. The shrews are all voracious animals, in spite of their small size, and some of the larger species are said to kill the smaller species of mice, especially the very young mice.

Chiroptera (Bats)

76. Little Brown Bat. *Myotis lucifugus lucifugus* (LeConte). 1831.

Bats are not common in the Northwest Territories. The brief summer season with short periods of darkness are not favourable for hunting insect prey on the wing. There are a few odd records of Little Brown Bat from the southwestern corner of Northwest Territories, and the writer saw one skin in a small collection of mammals made at Hay River, at the west end of Great Slave lake in the spring of 1908. There are no authentic records of other species of bats in the region, but J. D. Soper captured a Pale Brown Bat, *Eptesicus fuscus pallidus* (Young) at Pine lake, Wood Buffalo Park, about 20 miles south of the Northwest Territories border, on September 14, 1933, and it is quite probable that the latter species sometimes comes into the Northwest Territories.

Birds

The bird fauna of the Western Arctic and sub-Arctic region of Canada is primarily divided into two groups, Canadian and Arctic, wooded and unwooded regions. The great Mackenzie river, running to the northwestward and skirting the eastern slope of the Mackenzie mountains in the lower part of its course, carries a bird fauna which is essentially Eastern clear to the Arctic coast at about 138 degrees west longitude, actually farther west than Sitka and Juneau, Alaska. The sheltered Mackenzie River valley also carries many species far north of their normal range farther east. The robin, yellow warbler, and water thrush come "down north" to the lower islands of the delta, while traces of the Western (Pacific coast) fauna in species like the varied thrush and Say's phoebe are found in the delta.

Other northward-extending tongues of the Hudsonian Life Zone run up for a hundred miles or more north of the Arctic Circle, on the lower Anderson river near Liverpool bay, the Horton river near Franklin bay, and the Coppermine river near Coronation gulf. The birds of the wooded parts of the Northwest Territories include nearly all the species found in the woodlands of the northern parts of Alberta, Saskatchewan, and Manitoba—a long list containing most of the land and water birds of the Canadian-Hudsonian zones of the West. These can not be enumerated here, but the species recorded from the Northwest Territories can readily be picked out of the American Ornithologists' Check-List of North American Birds (1931) and the details of plumages and summaries of general habits are given in various recent books on North American birds, such as *Birds of Canada* (Taverner, 1934). Preble (1908) listed about 220 species of birds known in the whole Mackenzie region. Anderson (1913) published notes on about 170 species, mostly on the Arctic forms, the inland forms being only briefly discussed. In another chapter of this bulletin J. D. Soper notes the occurrence of 216 species in Wood Buffalo Park in 1935, this including a section of northern Alberta, and the 50 or more species recorded in the winter show that in a favourable place in the southern area a large proportion of the migrant species will show up at some time during the year.

A considerable number of geese and freshwater ducks breed in the lake and marsh regions, particularly of the Mackenzie valley, and are of some importance as food for the residents as well as in supplying a certain amount of migratory wildfowl for the south. The game ducks breed mostly in the deltas and overflow flats along the Athabaska-Slave-Mackenzie system. The greater area to the eastward, including part of the Canadian Shield, although well supplied with deep, clear lakes, provides little duck food and is of comparatively little importance as duck-breeding ground, so that the area does little to augment the autumn flight through the Prairie Provinces. While several species of freshwater ducks breed as far north as the Mackenzie delta, the Pintail is the only one of these that is at all common along the Arctic coast, although it almost never alights on salt water. The only duck really common everywhere in the Arctic is the Old-squaw which also breeds in the interior south to the timber-line. Geese are not numerous enough to be important in most parts of the Western Arctic, although scattered pairs of Canada Geese nest here and there. The Mackenzie delta has a considerable breeding population of Canada Goose, and Lesser Snow Goose breed east of the delta on Banks island and farther east. The White-fronted Goose is of general distribution, but does not seem to be common anywhere along the coast. Whistling Swans are fairly common east of the Mackenzie, particularly in the Langton Bay region. Black Brant breed abundantly here and there near the coast east of the Mackenzie and in the Cape Bathurst area, but are rare east of there, and none is found from Coronation gulf to the Eastern Arctic coast.

The more truly Arctic birds, although not numerous in species, are the ones which give a distinctive character to the region, both on the coast in summer and farther south and west during migrations and in winter. The space at the disposal of the writer makes it impossible to do more than sketch a few of the noteworthy peculiarities of the Northwest Territories avifauna as they appear from seven winters and ten summers sojourn in the region discussed. In comparison with the Eastern Arctic, the western region of the Northwest Territories has a low, flat coast which is favourable for shore-birds and tundra plains species The absence of murres, puffins, auks, and auklets in the Western Arctic region of Canada, and in fact on the Arctic coast east of point Barrow, while so abundant and characteristic of the Bering Sea and Kotzebue Sound region, is undoubtedly due largely to physiographic reasons. These birds are abundant on the west coast of Alaska as far north as cape Lisburne, but from thence eastward the coast is low, and affords none of the rocky cliffs which these birds delight in for nesting purposes. There is one record of Pallas' Murre from Herschel island and one of Least Auklet from Mackenzie delta. The Eastern species of these groups, Dovekie, Brunnich's Murre, Mandt's and Black Guillemot, Kittiwake, and so forth, which are so abundant on parts of the coasts of Labrador, Greenland and certain islands of the Eastern Arctic, do not penetrate the Arctic archipelago far enough to reach the rocky ledges of the Coronation Gulf region, which except for a few gull rookeries, is singularly lacking in sea-birds.

The Mackenzie delta is rich in summer bird life. There seems to be a slight migration to the westward in spring from the Mackenzie along the north coast of Yukon Territory. Numbers of geese and ducks appear to come over the low divide from the Yukon and Porcupine rivers and spread eastward along the coast. A considerable amount of the upper Mackenzie River migration does not come to the mouth of the river at all, but crosses from the Mackenzie to Anderson river and thence into Liverpool bay. Large numbers of Lesser Snow Geese come into Liverpool bay from the south as well as from the west, cross over cape Bathurst and go directly to Banks island, although numbers remain to breed on the mainland.

On the Arctic coast proper the migration, except for a few passerine birds, Snow Bunting, Longspur, Pipit and the like is virtually east-and-west, instead of north-and-south. The sea-ducks, gulls, jaegers, and many of the shore-birds come from Bering sea and the Pacific, some of them around the far northwest corner of Alaska, reaching the eastern limits of their range as far east as Banks island, Melville island, and Coronation gulf. East of Franklin bay the country is generally comparatively sterile or rocky, and the shores of Amundsen gulf, Dolphin and Union strait, and a large part of Coronation gulf show a surprising scarcity of birds, both in numbers and in species. Comparatively few birds come north by way of Coppermine river, but some birds come to Victoria island along the coast from the west.

The beautifully-coloured, Little Steller's Eider (*Eniconetta stelleri*) and the grotesquely-marked Spectacled Eider (*Arctonetta fischeri*) are essentially Siberian birds, and barely come into Canada from the west. The two eiders which might be of greater real importance along the Arctic coast are the circumpolar King Eider (*Somateria spectabilis*) and the Pacific Eider (*Somateria v-nigra*). These species are hunted little in Canadian territory, although at point Barrow, even before guns were used, large numbers were killed with throwing-sticks and bolas —missiles consisting of cords to the ends of which stone balls are fastened. The migrations are very regular and follow remarkably narrow and uniform paths from year to year. Early in spring they follow leads of open water along the edge of the floe-ice, but later in spring follow the coast from one black earth-bank to another, straight over the ice of the bays.

At cape Bathurst and Baillie Island post on the long peninsula between Liverpool and Franklin bays, during some seasons there may be observed an almost continuous migration of eiders, starting before the season of open water and lasting until after the freeze-up in the fall. Although the plain brownish females of both species are somewhat similar in appearance, the males are readily distinguished. The back of the King Eider is largely dark, while the Pacific Eider drake is so conspicuously white-backed that in flight he might almost be taken for a snow goose. The eiders appear over the ice on Liverpool bay coming from the west late in May, in flocks of varying size, the first flocks usually males, but later mixed indiscriminately. This eastward migration continues until well into June. The eiders begin nesting very soon after their arrival, and as soon as the eggs are laid the males start to drift back to the west, or at least all but occasional stragglers do so. In the latter part of June some seemed to be going west while a few were still moving to the eastward. That this was not a mere local drifting about seemed to be shown by the fact that eastbound fliers were still fat, while westward bound birds were becoming lean. At the end of June flocks flying west were practically all King Eider drakes, the numbers increasing after the first of July, usually when there was a favourable wind from the east, or only very light breezes from the prevailing northwesterly direction.

On July 11, 1912, a very large flight began about 9 a.m. and for about three hours a large flock would pass every few minutes; sometimes four or five flocks were in sight at once. They were mostly King Eider drakes—about one flock of Pacific Eider drakes to ten of King Eider—and occasionally a few Old-squaws. July 12 was foggy with a light northwest wind and few eiders were flying. The next day was warmer with the wind in the northeast, but a dense fog came in about 11 a.m. and hung on until 5 or 6 p.m. One small flock of male King Eider was seen going west in the fog and a flock of 15 to 20 Pacific Eider was seen in a narrow strip of shore water. About 8 p.m. the eiders began coming in great numbers from the eastward, until midnight, a few flocks coming for two or three hours longer. These flights kept up in varying numbers and by July 18 there were about as many Pacific Eiders as King Eiders flying, and the spring plumages were beginning to fade.

Only an occasional female duck was seen in these migrating flocks, presumably birds whose nests had been destroyed. On July 26 the ice began to go off shore, and the writer left cape Bathurst. The eiders were still coming west and from the experience of other seasons, it is known that the proportion of females in the flocks gradually increases, augmented by females that have lost their young, and later by the young eiders themselves. The writer has seen young eiders barely able to fly as late as October 1 and some stay around leads of open water until November. All by that time have acquired the mottled brownish plumage, which by a somewhat natural misnomer gave rise to the whalers' name of "canvasback" for the eider in the Northwest. There is here a practically continuous migration of eiders from May to November, though a late spring or an early autumn would naturally shorten the time.

In Beaufort Sea waters, the eiders are not much hunted as they pass off shore or along the coast outside the usual rim of Eskimo settlements. Ordinarily the little Cape Bathurst settlement did not kill many during the summer flight, as the ice usually went off shore rather early, and the natives could put down their fishnets. When the ice was out, the natives could not get under the main line of flight. However, when the pack ice remained solidly inshore, causing temporary hard times, the conditions could be ameliorated by a harvest of eider duck. As the King Eiders usually scatter in early summer and place their nests a little distance inland they are perhaps not easily adaptable to eider-down production, but the Pacific Eiders breed locally in large colonies on sandspit islands off capes Brown and Dalhousie, Horton River sandspit, and islands in

Franklin bay and in Dolphin and Union strait, where they obtain some security from the Arctic foxes. There is a possibility of developing an eider-down industry in certain areas.

The Northern Raven can not be called a typical Arctic bird, as it was formerly native to most boreal parts of the continent. It is not common in the Arctic, but is about the only bird which is consistently resident wherever it is found. The Willow Ptarmigan and Rock Ptarmigan usually winter locally in small numbers, but the great mass of them go farther south, and Snowy Owl and Gyrfalcon may be seen occasionally in winter during a "good year" for mice or ptarmigan. The edge of "the bush" usually harbours a few of the forest residents, but the real Arctic Zone is nearly birdless in midwinter.

The Willow Ptarmigan (*Lagopus lagopus*) and the smaller Rock Ptarmigan (*Lagopus rupestris*) are perhaps, by and large, the birds of greatest importance in the economy of the North. Widely distributed to the most northern islands, and prolific breeders, they form an important part of the food of the fur-bearing carnivores, and while not killed by the human inhabitants in large numbers in the aggregate, they are one of the most important assets of the country, being virtually the only feathered game available during the seven most severe months of the year. The ptarmigan is regarded with a friendly eye by most northerners, remaining in the back of the mind, not as a staple food, but as a bird which has the merit of appearing unexpectedly in time of emergency. On a long trap-line or on a winter hunt when the caribou and sheep fail, one or two of the "white chickens" may be life-savers, even picked up in little sinew snares when ammunition is lacking. The migration of the ptarmigan is probably never a complete one, but the bulk of the birds move south into the mountains or the bush country where their food of willow buds is available. The great flights of thousands may be partly due to periodic fluctuations in numbers of the species, but our records of abundance and scarcity of ptarmigan are very incomplete. More information is desired from northern observers who have permanent dwellings. The ptarmigan, except for minor fluctuations, will probably keep up their numbers for many years to come, as vast areas are unhunted, and most of the ptarmigan never come far enough south to be slaughtered for sport. The native Indians and Eskimos, regardless of the numbers which they kill, undoubtedly help to conserve the ptarmigan by trapping out the foxes, mink, marten, ermine, wolverine, and other predatory fur-bearing mammals which also have a taste for fowl.

It may be well to controvert the inherited folk-lore as well as propaganda prevalent among sportsmen in more southern districts (in Canada as well as in the United States) that the game birds, particularly swans, geese, ducks, and shore-birds are being exterminated by Eskimos and Indians somewhere in a vague North Country. The average native is not a hunter for sport, and in most districts ammunition is too expensive to waste on small returns. The territory is so large that only a relatively small section is hunted frequently, and there is virtually untouched breeding ground in every district. As cliffs for rookeries are scarce, egging in quantity is seldom practised as in Western Alaska and Greenland. Native dogs do some foraging around the villages, but do not range far, and as with their owners, the depredations are very local. A white man, located at some permanent trading post or expedition headquarters is apt to get exaggerated ideas of the potentialities of the native as a destroyer of wild life. Wherever a white man settles, the natives come in to visit or to trade, singly, by families, or in bands, and settle down for a time. Meanwhile, they crave fresh meat, regardless of other rations, and necessarily the small mammal and bird life is pretty well cleaned out within a radius of a few miles. This is compensated for by the fact that a much larger range is left unhunted during the time the natives are away from their own homes.

References

The earlier works on Arctic exploration usually have more or less extended notes on the larger mammals and birds scattered through their text and a complete bibliography is far too lengthy for this section. The following list includes the more important faunal papers on the district and a few shorter papers from which citations have been made.

American Ornithologists' Union

1931—Check-List of North American Birds, prepared by a Committee of the American Ornithologists' Union, Fourth Edition, constituting the "Systema Avium" for North America north of Mexico. Published by the American Ornithologists' Union, Lancaster, Pa., pp. xix, 526.

Anderson, R. M.

1913—Report on the Natural History Collections of the Expedition (1908-1912), pp. 436-527, illustrated, in "My Life with the Eskimo," by V. Stefansson. New York: The Macmillan Company. (Insects, pp. 448-449; Fishes, 450-455; Birds, 456-494; Mammals, 494-527.)

1934—Mammals of the Eastern Arctic and Hudson Bay. pp. 67-137. In Canada's Eastern Arctic, Department of the Interior, Ottawa.

1934—"Notes on the Distribution of the Hoary Marmots," Canadian Field Naturalist, Vol. 48, No. 4, April, 1934, pp. 60-63, with map.

Degerbøl, Magnus, and Freuchen, Peter

1935—Report of the Fifth Thule Expedition 1921-24. The Danish Expedition to Arctic North America in charge of Knud Rasmussen, Ph.D., MAMMALS. Gyldendalske Boghandel, Copenhagen. p. 278. Part I. Systematic Notes, by Magnus Degerbøl, Ph.D., pp. 1-67, Part II, Field Notes and Biological Observations, by Peter Freuchen, pp. 68-278.

Franklin, John

1823—Narrative of a Journey to the Shores of the Polar Sea, in the years 1819, 20, 21, and 22. Zoological Appendix: Mammals and Birds by Joseph Sabine. London.

Franklin, John and Richardson, John

1828—Narrative of a Second Journey to the Shores of the Polar Sea, in the years 1825, 1826, and 1827. London.

Hoare, W. H. B., and Anderson, R. M.

1930—Conserving Canada's Musk-oxen, being an account of an investigation of Thelon Game Sanctuary, with a brief history of the area and an outline of known facts regarding the musk-ox. By W. H. B. Hoare, Department of the Interior, Ottawa, p. 53.

Appendix B. Notes on the Musk-ox and the Caribou, by R. M. Anderson, Ph.D. With maps of present distribution of musk-oxen and caribou. pp. 49-53.

Howell, Arthur H.

1915—Revision of the American Marmots, North American Fauna, No. 37, U.S. Dept. of Agriculture, Bureau of Biological Survey. Washington. p. 64, map p. 58.

1936—"A Revision of the American Arctic Hares," *Journal of Mammalogy*, Vol. 17, No. 4. November 14, 1936. pp. 315-337, figs. 4, including distribution map.

MacFarlane, Roderick

1891—Notes on and List of Birds and Eggs collected in Arctic America, 1861-1866. Proc. U.S. National Museum, XIV, pp. 413-466. Washington.

1905—Notes on Mammals collected and observed in the Northern Mackenzie River District, Northwest Territories of Canada; with remarks on Explorers and Exploration of the Far North, Proc. U.S. National Museum, xxviii, pp. 673-764. Washington.

Merriam, C. Hart

1918—Review of the Grizzly and Big Brown Bears of North America (Genus Ursus). North American Fauna, No. 41, U.S. Dept. of Agriculture, Bureau of Biological Survey, Washington, p. 136.

Murie, Olaus J.

1935—Alaska-Yukon Caribou. North American Fauna, No. 54. U.S. Dept. of Agriculture, Bureau of Biological Survey, Washington, p. 93.

Nelson, Edward W.

1934—"New Subspecies of the Arctic Hare," Proc. Biol. Society, Washington, Vol. 47, pp. 83-86.

Pocock, R. I.
1935—"The Races of *Canis lupus*," Proc. Zool. Soc. London. 1935, Part III, pp. 647-686.

Preble, Edward A.
1902—A Biological Investigation of the Hudson Bay Region, North American Fauna. No. 27, U.S. Dept. of Agriculture, Division of Biological Survey, Washington, pp. 140.
1908—A Biological Investigation of the Athabaska-Mackenzie Region. North American Fauna, No. 27, U.S. Dept. of Agriculture, Bureau of Biological Survey, Washington, p. 574.

Richardson, John
1829—Fauna Boreali-America; or the Zoology of the Northern Parts of British America. Part First. Quadrupeds. London. 4to. pp. xlvi, 300.
1851—Arctic Searching Expedition; A Journal of a Boat-voyage through Rupert's Land and the Arctic Sea. London.

Russell, Frank
1898—Explorations in the Far North. Being the report of an expedition under the auspices of the University of Iowa, 1892, '93, and '94. Published by the University, Iowa City, Iowa. p. 290, illustrated.

Swainson, William, and Richardson, John
1831—Fauna Boreali-Americana, Part Second. The Birds. London. 4to. pp. lxvi, 534.

Taverner, P. A.
1934—Birds of Canada. National Museum of Canada. Bulletin No. 72, Biological Series, No. 19, Ottawa. p. 475, plates 87, figs. 488.

FISH

Commercial fishing is practically negligible in the Mackenzie, Keewatin, and Franklin Districts but this condition is due to sparseness of population and absence of transportation facilities rather than to lack of fisheries resources. So far as the Mackenzie and Keewatin Districts are concerned it is known that their waters contain many kinds of fish, at least some of them in apparent abundance. Information as regards the fish to be found in the Franklin area is more limited. "In the islands constituting the District of Franklin," says J. R. Dymond, Director of the Royal Ontario Museum of Zoology, Toronto, who has assembled data relative to fisheries resources in the North, "it is probable that there are no strictly freshwater species and the most important food fish is the Arctic Char, often called Sea Trout or Salmon. Little appears to be known of the marine fishes of the region." He adds, "Perhaps the most important from the economic standpoint are the Greenland Cod, the Northern Pollack, and Pacific Herring."

In the Mackenzie and Keewatin Districts, on the other hand, Dymond states, the numerous lakes and rivers "contain an abundance of the finest food fishes, including Whitefish, Lake Trout, Arctic Char, Inconnu, Tullibee, Grayling, and Yellow Pickerel. Among fishes of secondary importance are Pike, Sucker, Goldeye, and Ling." Similar testimony as regards the presence of at least most of these fishes has been given by officers of several branches of the Dominion Government service on duty in northern territories.[1] Reports supplied by some of these officers to the Department of Fisheries also record the presence of Sea Herring, Tomcod, White Whale, and Hair Seal on the Mackenzie District coast. It is further stated (Kemp) that Bowhead Whale are sometimes sighted off the coast, although infrequently.

Following are summaries or condensations of statements by Dymond[2] as to the different species occurring in one or other or, in some cases, all three districts:

Whitefish (*Coregonus*, sp?).—Whitefish occur in nearly every lake and many of the streams of Mackenzie and Keewatin Districts. Richardson (1836) noted that these fish formed the principal food at many of the fur posts for eight or nine months of the year and Preble (1908) said that the sites of many of the trading posts, as well as the wintering stations of a number of exploring expeditions, were "selected with a view to the local abundance of this fish."

---

[1]Report by Inspector T. B. Caulkin, Royal Canadian Mounted Police, on fisheries in the vicinity of the mouth of the Mackenzie river, 1927; report by Inspector V. A. M. Kemp, Royal Canadian Mounted Police, 1928; report by John A. McDougal, District Agent, Department of the Interior, Fort Smith, 1930; report by C. Bourget, M.D., Indian Agent, Department of Indian Affairs, Resolution, 1930; report by J. A. Urquhart, Medical Officer of Health, Department of the Interior, Aklavik, 1930.

[2]Memorandum to the Department of Fisheries, Ottawa, 1936. References cited in the memorandum are as follows: (1) Dymond, J. R. 1932. Notes on the distribution of *Salmo salar* and *Salvelinus alpinus* in northeastern Canada. Canadian Field-Naturalist, 26: 185. (2) Hornby, J. 1934. Wild life of the Thelon river area, Northwest Territories, Canada. Canadian Field-Naturalist, 48: 109. (3) MacFarlane, R. 1891. Second Report Committee of Senate (Canada) on Mackenzie basin, p. 54. (4) Melvill, C. D. 1915. Report on fisheries investigations, Hudson and James bays and tributary waters, in 1914. Appendix Annual Report Department Naval Service for year ending March 31, 1914. Ottawa. (5) Melville, J. C. D., 1914. Notes on the distribution and economic importance of the "inconnu" (*Stenodus mackenzii*) in the Mackenzie river valley. Department Marine and Fisheries, 47 Report pp. 238-243. (6) Preble, E. A., 1908. A biological investigation of the Athabaska Mackenzie region. N. A. Fauna No. 27. (7) Richardson, John, 1836. Fauna Boreali-Americana, Part III, The Fish. London. (8) William, M. Y., 1922. Biological notes along 1,400 miles of the Mackenzie river system. Canadian Field-Naturalist, 36: 61.

Preble added that in some lakes the whitefish attained a weight of eight, twelve, or even twenty pounds, though the average weight was much less—from two to four pounds.

Round Whitefish or Frost Fish (*Prosopium quadrilaterale* Richardson).—While this species is found, its distribution and abundance are not known. It was originally described by Richardson from specimens taken at Fort Enterprise.

Other Whitefish.—Other species of Whitefish have been described from the area under consideration but it is not yet definitely known how many species really occur. Preble says that "at least two species of *Coregonus*, the smaller of which is called locally 'broken nose,' are abundant in the lower Peel and Mackenzie rivers nearly throughout the summer."

Lake Trout (*Cristivomer namaycush* Walbaum).—This fine food and game fish is widely distributed throughout the whole of the Mackenzie and Keewatin area. It is typically an inhabitant of lakes but resorts on occasion to clear, swift rivers leading to or from the lakes. Its size varies from lake to lake but in the larger waters it sometimes reaches a weight of fifty pounds. Williams (1922) records the capture of two specimens nearly three feet in length at Wrigley harbour. Preble (1908) says that the fish abound on the eastern and northern arms of Great Slave lake and in Great Bear lake.

Arctic Char (*Salvelinus alpinus* Linnaeus).—Arctic Char is the most abundant and valuable food fish found along the Arctic coasts of the Dominion, including the islands of the Franklin District, ranging to 83° north latitude at least. They are sometimes spoken of as "sea trout" to distinguish them from the Lake Trout (*Cristivomer*) and, farther south, from the Speckled Trout (*Salvelinus fontinalis*). In the northern regions and in Hudson bay they are quite often called "salmon" but the true Atlantic Salmon is not known west of cape Hopes Advance (Dymond, 1932). Several distinct species of the genus *Salvelinus* have been described from the northern coasts of Canada, including *S. stagnalis*, *S. rossii*, *S. hearnii*, *S. alipes*, and *S. nitidus*. How many of these are actually distinct species, however, is still open for investigation. The Arctic Char resorts to fresh water for spawning but appears to spend a good deal of its adult life in the sea, particularly in the vicinity of river mouths. Some are said to spend their entire life in fresh water, for the most part in lakes. No very definite information is available as to how large the Arctic Char grows. Richardson reported the individuals in one large catch as varying in weight from two to fourteen pounds.

Inconnu (*Stenodus mackenzii* Richardson).—Although the Inconnu or, as it is popularly known, the "conny" is not a food fish of the first quality, its abundance and large size—sometimes the fish weighs sixty pounds—give it considerable economic importance in the North. It belongs to the Whitefish family but in some respects it is intermediate between a Whitefish and a Trout. The mouth, equipped with numerous small teeth, is larger than that of the Whitefish. The same species as occurs in Canada's North, or one very similar to it, is present in many of the Siberian rivers emptying into the Arctic.

The Inconnu occurs in Anderson and Mackenzie rivers, in Great Slave lake, and in rivers flowing into the lake from the north. It has also been reported as ascending Peel river and as having been taken in the Talston as far up as the first rapids. In Slave river it is not found above Fort Smith. According to Melville (1914), "connies" have been found in Great Slave lake as far east as the Narrows. "They also ascend most of the rivers flowing in from the north, but Rivière des Rochers, Stony Island river, Buffalo river, and Slave river, all tributaries of Great Slave lake, are the localities," says Melville, "where the 'Inconnu' are, at spawning time, probably most plentiful." Sergeant Mellor,

R.C.M.P., reports that "he was nearly able to walk across Buffalo river on their backs," and the same has been said of Rivière des Rochers. In upper Mackenzie river the Inconnu are probably not as plentiful as in Slave river but some are taken in gill nets every summer at all the trading posts. They do not ascend Liard or Great Bear rivers and they do not occur in Great Bear lake, although Thomas Simpson (Dease and Simpson Expedition, 1836) reported that one was caught in a whitefish net near Fort Confidence. In the lower Mackenzie the fish ascend from the Arctic ocean in great quantities as far as the Swift river (known as the Sans Sault rapids) above Good Hope.

Smaller specimens of Inconnu are stated to be quite palatable but the larger fish are regarded by some as over oily and rank. Some persons report the fish as making good food when dried and smoked.

Tullibee: Lake Herring (*Leucichthys*, sp?).—The fish commonly called Lake Herring or Ciscoe in the Great Lakes regions are usually known as Tullibee in the Northwest, especially the larger kinds. Several species have been described from the Northwest but pending more complete study of the subject it is impossible to say how many species actually occur.

Tullibee are usually taken in the same waters as Whitefish and, according to Preble, they occur north to the Arctic coast. In Hudson and James bays they run into brackish water from the rivers, and reports have been received of the same condition occurring at the mouths of some of the rivers emptying into the Arctic. Preble quotes Père Giroux as saying that Tullibee were extremely abundant at Arctic Red River in September, when they spawned in very deep basins in the Mackenzie. Simpson reported Tullibee taken near the mouth of the Coppermine.

Fish of Great Bear lake were described by Richardson under the name *Leucichthys lucidus*. This fish is said to be extremely abundant in Great Bear lake and to ascend Mackenzie, Anderson, and other rivers in the summer, presumably to spawn. On the Mackenzie it is said to ascend the river as far as Fort Simpson, at least. It has been recorded from Herschel island and other points west of the Mackenzie. The species is small but its flesh has excellent flavour.

Grayling (*Thymallus signifer* Richardson).—Commonly called "bluefish" in the Mackenzie and Yukon regions, the Grayling appears to be widely distributed throughout the Keewatin and Mackenzie Districts to the shores of the Arctic but is restricted to clear streams and lakes. Preble (1908) found the fish "in the lake country between Great Slave and Great Bear lakes and at a number of points on the Mackenzie ... especially abundant in the rapid stream which I descended to McTavish bay in August, 1903 ... common also in Great Bear lake near Fort Franklin a little later ... most of the tributaries of the Mackenzie ... scarce in the Liard below the mouth of the Nelson but common above that point." Williams (1922) caught two specimens at Wrigley harbour and reported the fish as common at Smith creek, twelve miles above Wrigley post. Hornby (1934) "caught a few below Dickson's canyon (Hanbury river) ... below Helen's falls these Grayling were plentiful."

Pike:Jackfish (*Esox lucius* Linnaeus).—Pike are said to be extremely abundant in practically all the waters of the Northwest but to be absent from the Arctic islands. Williams (1922) found them very common and reaching a length of as much as three feet at Wrigley harbour.

Pike Perch: Doré: Yellow Pickerel (*Stizostedion vitreum* Mitchill).—Popularly known under several different names, this excellent food fish and semi-game fish is reported as rather common as far north as Great Slave lake, where it occurs in some numbers. Preble (1908) captured specimens as far north as the lower Grandin river, north of Rae. He was told that the fish is fairly common in Willow or Horn river, near Providence.

Northern Sucker (*Catostomus catostomus* Forster).—This species appears to be the common sucker in the waters of the Northwest. Preble reported it extremely abundant throughout the Mackenzie valley. In some localities considerable numbers of the fish are taken in winter in nets set beneath the ice. The Sucker is plentiful at the mouth of Mackenzie river in June.

Red-horse (*Moxostoma aureolum* LeSueur).—This fish, which is the same species as that described by Richardson (1823) under the name *M. lesueurii* from Pine Island lake, Saskatchewan, is reported by Preble (1908) as being equally as common as the Northern Sucker in many localities. "It is a common fish," he says, "in Great Slave lake and in the Mackenzie." It is stated to appear at Arctic Red River about the first week of June, remain in abundance for something like three weeks, and then virtually to disappear. One specimen examined measured 18 inches in length.

Goldeye (*Hiodon alosoides* Rafinesque).—Preble (1908) found the Goldeye "a rather common inhabitant of Athabaska river, Athabaska lake, and Slave river, becoming scarcer northward and being practically unknown north of Great Slave lake.... The most northern record... Fort Norman, at mouth of Bear river. It was considered a great rarity."

Burbot: Ling (*Lota maculosa* LeSueur).—Known both as Ling and Burbot, this species is widely distributed throughout the Mackenzie and Keewatin Districts. It is said to occur also in the shore waters of the Arctic ocean. While this fish is less used as a food than various other species, Melvill (1915) reports that along the east coast of James bay it is considered excellent for food purposes by Europeans and natives alike. Richardson (1836) records that the roe, when well bruised and mixed with a little flour, was baked into very good biscuits and that the liver was also thought a delicacy. A closely related species in Europe is considered "a delicate flavoured dish."

Pacific Salmon (*Oncorhynchus*, sp?).—Occasional specimens of Pacific Salmon are taken in the Mackenzie but they are too rare to be of any economic importance. Preble (1908) quotes Père Giroux as saying that among thousands of Whitefish taken at Arctic Red River in the course of the autumn there would perhaps be three or four Pacific Salmon. These fish are also said to be taken occasionally in Peel river.

Bean (1894) says that one species of Pacific Salmon is found well to the eastward of point Barrow, and he remarks: "It is quite probable that this species, the little humpback, extends its migrations to the Mackenzie."

Greenland Cod (*Gadus ogac* Richardson).—This northern codfish is taken about some of the islands of the District of Franklin.

Northern Pollack (*Boreogadus saida* Lepechin).—This small member of the Cod family is a characteristic species of the Arctic seas of Asia and America from Greenland to Siberia and is generally common. It grows to a length of six or eight inches. By some writers the spelling "pollock" is used instead of "pollack."

Other Species.—Species of little or no direct economic value occurring in waters of the northern districts include the Sticklebacks (*Pungitius pungitius* and *Gasterosteus aculeatus*); the Sculpins (*Cottus cognatus*, *Myoxocephalus groenlandicus*, and *Oncocottus hexacornis*); and the Cyprinids (*Couesius plumbeus*, *Platygobio gracilis* and perhaps others).

Other Observers' Reports

The foregoing information based on the Dymond memorandum may be supplemented in some measure by extracts from the reports referred to in footnote [1] as having been made for the Department of Fisheries by several federal

[1] See page 123 for complete list of references.

officers stationed in the northern districts. These officers did not write as trained ichthyologists but their reports are of interest and value as being founded upon observations and inquiries which were made during residence in the areas concerned.

Under the name Salmon, Caulkin (1927) reports the occurrence of fish, probably Arctic Char "around Bernard harbour, and particularly Coppermine and Tree rivers" where the fish were said to be found "in large quantities during the summer months." In 1917, when camped at the mouth of the Coppermine during August and September, the report said further, "we had to lift our nets twice per day, owing to the weight of fish accumulating." Urquhart (1930) also spoke of the Coppermine as having "a very good run of Salmon." No further information is available as to the species to which these fish belong but Caulkin described them as of "a mixed variety, some being white and others red," and averaging "between twelve and twenty pounds in weight." In this connection it may be noted that Dymond has stated that the true Atlantic Salmon is not known west of cape Hopes Advance, but that both he and Bean have recorded the occasional presence of Pacific Salmon in Mackenzie river and on the coast. Dr. Rudolph M. Anderson, of the National Museum, Department of Mines and Resources, who was a member of the 1908-12 Canadian Arctic Expedition and made collections of marine and freshwater fish of the Arctic, states that he "was with parties which fished (netted) in both those regions pretty thoroughly in 1911 and again in 1914-16" and he is "well satisfied that the true Salmon does not occur there." The fish in question in his opinion is "the Arctic Char (*Salvelinus* sp.) and the Canadian Arctic Expedition 1913-18 brought out many specimens. Most of the white men in the region call this fish 'Salmon Trout' or 'Dolly Varden.' The males are usually bright red underneath in the spawning season, late summer and autumn, while the females are paler in colour, and when 'sea-run' in summer are nearly white, although they usually show signs of pink spots on sides."

Dr. Anderson also stated that "he brought out specimens of three species from the Cape Bathurst region, two of which are elsewhere important food fishes: California or Pacific Herring, *Clupea pallasii* Cuvier and Valenciennes, which appears in large schools around cape Bathurst in late summer, so abundant that with a 200-foot sweep-net they brought in about 13 barrels (about 3,000 fish) at one sweep. Also the Arctic Smelt, *Osmereus dentex* Steindachner, and Starry Flounder, *Platichthys stellatus* Pallas."

Caulkin and Kemp both reported the presence of Salmon Trout along the coast. (Possibly their references are to a fish of the genus *Salvelinus*.) Caulkin spoke of this fish as being taken at Herschel island, which is some seventy-five miles west of the Mackenzie. Kemp told of the occurrence of a species "variously called the 'Arctic Trout' and 'Salmon Trout'" in the salt waters of the coast but noted that it was not present in the immediate vicinity of the Mackenzie delta where the water is fresh. Both officers described the fish as having dark green speckled backs and light coloured undersides. Caulkin stated that the average weight of Herschel island specimens was from eight to ten pounds but the fish seen by Kemp were said to weigh only from two to six pounds. "The meat," Kemp added, "is very similar to Pacific Salmon, both as to colour and taste."

Both inspectors made reference to Herring as among the salt water species present on the Mackenzie coast. Kemp also listed Tomcod, which he described as measuring "from four to eight inches in length." In discussing Herring, Caulkin said that apparently they "frequent all the coves along the coast for some thirty miles west of the mouth of the Mackenzie but do not frequent the waters about Herschel island. They seem to disappear in the fall, just before freeze-up."

Kemp noted that White Whales, highly prized by the Eskimos, who eat the flesh and use the skin for waterproof boots, were "fairly numerous" around the mouth of the Mackenzie. Hair Seals were stated to be fairly abundant, and, like White Whales, much sought by the natives. Bow-head Whales were "rarely seen in the waters close to the coast and . . . it is some years since one was seen close to Herschel island. One is occasionally sighted off Baillie island."

JACKFISH, INCONNU, CROOKEDBACK AND WHITE FISH
TAKEN NEAR AKLAVIK

Mackenzie and Slave Rivers, Great Slave Lake, Great Bear Lake.—In his report (1930) McDougal treated Mackenzie and Slave rivers and Great Slave lake and Great Bear lake as the major waters of the Northwest Territories and all other lakes and streams as minor waters. Similarly, he made a distinction between different groups of fish, listing Whitefish, Trout, Freshwater Herring, and Inconnu as "fine" and all others as "rough."

Having made these classifications or distinctions, McDougal stated that in the major lakes "'fine' fish abound in commercial quantities, as well as the usual complement of 'rough' fish" but that "no commercial fishing of any magnitude" had taken place. At least three distinct species of trout were stated to occur, some of the fish reaching fifty pounds in weight. Whitefish in Great Bear lake were said to reach weights of from twelve to fifteen pounds in some cases. "Fresh-water Herring occur in abundance in Great Bear lake, particularly at the source of Great Bear river," McDougal added. "Herring are also caught in abundance in the lower waters of the Mackenzie, the most southerly point of their ascent being The Ramparts, near Good Hope."

Bourget (1930), referring to the Great Slave Lake district, recorded the presence of Whitefish, Bluefish, Inconnu, Trout, and Jackfish in various parts of the lake. Suckers and one or two other species were also reported. Measure of

abundance of the different species was stated to vary in different parts of the lake but, in general, Whitefish, Trout, Jackfish, and Inconnu were reported as quite abundant. Trout catches included some fish weighing up to forty pounds. Some of the Inconnu were also described as "very large." Bourget expressed the opinion that "the possibilities of commercial fishing (on Great Slave), once transportation is improved, will be tremendous as this lake, of such dimensions, should bring reserves good for years."

So far as Great Bear lake is concerned, a fur trader of the district, A. W. Boland, writing to the Department of Fisheries in 1930, stated that "the so-called Bear Lake Herring may be caught in large quantities." Herring taken at the head of Bear river, "the only place that is fished continuously year after year," averaged a pound and a half in weight. Where rivers enter the lake, "Whitefish are fairly numerous during the summer months." In the main body of the lake, Trout were reported to be the principal catch.

Mackenzie Delta and Adjacent Territory.—Urquhart's report of 1930 made reference to the fisheries in the area from Arctic Red River north through the delta to Herschel island in the west and Kittigazuit in the east. In this area, it was stated, there was no commercial fishing, strictly speaking, although some dry fish was sold by the Indians in summer months. The bulk of the catch was said to be made up of Jackfish (Pike) and Whitefish, "or varieties of the white, though there are at times some very good runs of Herring, both in the river and on the coast." Quite large catches of Ling were reported as taken in the autumn and used for dog food. "The occasional Salmon Trout here is a delicacy but quite rare," Urquhart added, "the 'white,' including 'crooked backs,' being the staple eating fish." It was in this report that Urquhart also made reference to the Coppermine river as having "a very good run of Salmon."

Like other observers, Urquhart reported the capture of Seals and White Whales in coastal waters. "At White Fish Station, just east of Shingle point . . .," he said, "there are possibly a hundred or more (White Whales) taken each season."

FLORA*

Oddly enough some of the very first botanical collections ever made in Canada came from the country west of Hudson bay, then known as Rupert's land, part of which is now included in the present Northwest Territories.

By far the most important of these were made by the naturalist and explorer John Richardson who, between the years 1819 and 1827 accompanied, as physician and naturalist, Franklin's first and second expeditions "to the shores of the Polar sea." Large numbers of common Canadian plants and animals, until then unknown to science and to the rest of the world, were described from specimens collected by Richardson and other members of the Franklin expeditions. It is but a fitting recognition of the work done that so many Canadian plants and animals are named in honour of such men as Richardson, Franklin, Drummond, Sabine, and Parry, to mention but a few of those intrepid pioneers in the scientific exploration of Canada, who often under the greatest difficulties, personal danger, and hardship brought back to the outside world specimens of the then unknown Canadian flora and fauna. Some of Richardson's plants were described and named by himself, others by Robert Brown in the botanical appendices to the reports of the Franklin expeditions. In all, Richardson reported 474 species of flowering plants and ferns, in addition to lower cryptogams, from what is now known as the Northwest Territories.

In 1819 another British expedition under Parry, in the *Hecla* and the *Griper*, wintered on Melville island. The botanical collections made by Edward Sabine and other members of the Expedition were described by Robert Brown in his famous *Chloris Melvilliana*, London, 1823, thereby laying the foundation of our present knowledge of the flora of Canada's Arctic islands. Between 1833-40 appeared W. J. Hooker's classic compilation *Flora Boreali-Americana* which until this day remains one of the standard handbooks on the flora of northern North America. As far as the western Arctic is concerned information on the flora was based almost entirely on the results brought back by Franklin's and Parry's Expeditions.

In 1859 a young United States naturalist, Robert Kennicott, descended Mackenzie river to the Peel, and crossed the Mackenzie mountains into Alaska. Owing to Kennicott's premature death in 1866 a description of his small, but important botanical collection, was never published.

In the years between 1887 and 1900 important contributions were made by members of the Topographical Survey and the Geological Survey of Canada, from the then unexplored country between the Mackenzie drainage basin and Hudson bay by J. B. and J. W. Tyrrell, and from the western shore of Hudson bay by R. Bell.

A comprehensive account of the trees and shrubs of the Mackenzie basin was given by E. A. Preble in an appendix to his monumental *Biological Investigation of the Athabasca-Mackenzie Region*, published by the United States Department of Agriculture—North American Fauna No. 27, 1908.

John Macoun in his *Catalogue of Canadian Plants* completed in 1890 included some of the collections of the latter part of the nineteenth century, but for the geographical distribution of Arctic plants depended in the main upon Hooker's Flora. Later additions, including the important collections made on the west shore of Hudson bay by J. M. Macoun, were published in appendices to reports of the Geological Survey of Canada.

---

*By A. E. Porsild, Department of Mines and Resources.

In 1913 appeared Simmons' *Survey of the Phytogeography of the Arctic American Archipelago* based upon his work as a botanist with Sverdrup's expedition in the *Fram*, 1898-1902, as well as upon the published and unpublished records of all previous collectors in the archipelago. Since the appearance of this standard work important collections were made during the Canadian Arctic Expedition, 1913-18, by various members of the southern party under the command of R. M. Anderson. This expedition collected plants along the mainland Arctic coast from Alaska eastward to Bathurst inlet and also from the southern part of Victoria island. The results of the botanical work were published in Vols. IV and V of the scientific report by J. M. Macoun, Theodore Holm, and others.

In 1936 Hugh M. Raup published his *Phytogeographical Studies in the Athabaska-Great Slave Lake Region* chiefly based on the very extensive collections made by himself in the course of several expeditions to that region.

Arctic Prairie North of Yathkyed Lake
The ground is covered with a firm sward of Arctic sedges and grasses, too short to cut but excellent for grazing.

Members of the Fifth Thule Expedition 1921-24 under the leadership of Knud Rasmussen collected plants, chiefly in the Keewatin District and an account of their work has been published recently by Johs. Grøntved. *Report of Fifth Thule Expedition*, Vol. II, No. 1.

In 1927-28 the writer with his brother, R. T. Porsild, while engaged in a grazing reconnaissance, collected plants in the northwestern part of the Mackenzie District, between Mackenzie and Anderson rivers and from the Great Bear Lake basin. These collections were added to during the years 1932-35 when the writer was stationed in the Mackenzie delta.

In 1931 the writer made a botanical survey of central Keewatin, from the Yathkyed Lake basin down Kazan river to Baker lake. The botanical collections from this and earlier expeditions aggregate 8,000 numbers or over 40,000 herbarium sheets. A report on the flora of northwestern Mackenzie District, based upon the above collections, is now in course of preparation.

Only a few trained botanists have visited the Northwest Territories, and most of the collections of plants that have found their way into botanical museums have been made by travellers who have had no special botanical training and to whom the collection of plants was not the principal objective. For this reason some of the difficult and critical families, such as grasses, sedges, and willows, are, as a rule, but poorly represented in their collections. Until the advent of the aeroplane all travellers in the north, at least during summer, were compelled to follow the rivers and navigable canoe routes. Our present knowledge of the flora, therefore, is confined to areas accessible by water, and for this reason large parts of the Northwest Territories remain among the least known land areas in the northern hemisphere.

ARCTIC FLORA IN RELATION TO MAN

Generally speaking, few of the plants native to the Northwest Territories are at present of economic importance to man. Of greatest importance to the inhabitants, of course, are the arborescent species of woody plants capable of producing lumber and firewood. The white spruce is by far the most important of these because of its predominance and the quality of its wood. Balsam poplar, aspen, Banksian pine, black spruce, tamarack, and birch are all used for firewood when available. The wood of the last two is tougher and harder than that of the white spruce, and for this reason finds a limited use in the local manufacture of tools and implements.

North of the limit of trees, heath and berry bushes, with stunted willows, alder, and ground birch, are used by the Eskimos for cooking purposes during summer. Of greatest importance, however, for this purpose is the white heather (*Cassiope tetragona*), which is found everywhere and is so rich in resin that it will burn even when moderately wet. Dr. Rae depended entirely on white heather for fuel during the two winters he spent at Repulse bay, 1846-47. All species of fruticose lichens when dry are highly inflammable and are used for fuel by the Eskimos.

Indirectly the vegetation is of importance to man since nearly all sedges, grasses, and fruticose lichens, in addition to a number of other herbaceous plants, furnish food for grazing animals. The young shoots of willows and other woody plants are eaten by moose and other browsing animals, and the seeds, winter buds, and other parts of plants are eaten by game birds as well as by small mammals which in turn constitute the food of some of the fur-bearing animals.

A number of plants found in the North are edible and a limited use is made of some of these by the aborigines and white inhabitants of the Northwest Territories. A pamphlet entitled, *Edible Roots and Berries in Northern Canada*, in which a score or so of edible roots, greens, and berries are described and pictured, is now being published by the National Museum of Canada. Of greatest food value perhaps are the lichens. Species of black and grey *Gyrophora*, the "rock tripe" or "tripe de roche" of the voyageurs, that grow on acid rocks throughout the Northwest Territories with a few of the fruticose species were regularly used and on more than one occasion saved the lives of parties during the Franklin expeditions.

The nutritive element in the lichens is largely lichenin, a carbohydrate akin to starch, which when cooked is digestible by humans. In order to use the lichens for food purposes it is necessary first to neutralize the acid contained by most species. The aborigines of North America have never made use of the lichens, nor, so far as the writer is aware, of any of the edible fungi that are common in the North. In northern Europe a number of species of lichens have found a more extensive use. Several species of "reindeer moss" (*Cladonia* and *Cetraria* spp.) were formerly used regularly mixed with flour. In more recent

times they have been used commercially in some countries in the manufacture of alcohol, and as fodder for cattle and other domestic animals. Lichens form the principal food of caribou and domesticated reindeer during the winter and it is only where these plants occur abundantly that reindeer can be maintained successfully. One or two species of lichens are used by the aborigines of the Northwest Territories for dyeing purposes.

THE FLORA

Notwithstanding the vast extent of the Northwest Territories its flora is very uniform. This is partly owing to the absence of high mountain barriers and partly to the very uniformly dry continental character of the climate of the interior plains, but perhaps most of all, because the flora, compared with that of Alaska and other parts of Canada, is very young.

During the maximum extent of the Keewatin ice-sheet most of the Northwest Territories was covered by glaciers and it was only in comparatively recent times, upon the recession and disappearance of the ice, that this vast land area became available to plants. The comparative youth of the flora is indicated by the fact that perhaps less than a dozen species of vascular plants are endemic or peculiar to the Northwest Territories, and that so few species of Asiatic or Cordilleran origin have had time to cross the Mackenzie river which now sharply divides the flora of the Northwest Territories from that of Alaska and the Pacific coast.

A tentative enumeration of all the flowering plants and ferns known to occur in the Northwest Territories west of Hudson bay, including large numbers of still unpublished additions deposited in the National Museum of Canada, aggregates but little over 750 species, distributed in 74 families. Our present knowledge of the lower forms of plant life such as mosses, algae, lichens, and fungi—not to mention the lowest forms—is still very imperfect and it is not even possible now to estimate their numbers. Future exploration, particularly in the botanically unexplored eastern slope of the Mackenzie and Richardson mountains, no doubt will add a great many species as yet unrecorded from the area. Nineteen families each contain ten species or more. They are as follows: *Cyperaceae* (sedge family) 86, *Compositae* (composite family) 70, *Gramineae* (grass family) 56, *Cruciferae* (mustard family) 49, *Salicaceae* (willow family) 36, *Rosaceae* (rose family) 34, *Caryophyllaceae* (pink family) 33, *Leguminosae* (pea family) 31, *Ranunculaceae* (buttercup family) 29, *Saxifragaceae* (saxifrage family) 27, *Scrophulariaceae* (figwort family) and *Ericaceae* (heath family) 21 each, *Juncaceae* (rush family) 17, *Polygonaceae* (buckwheat family) 15, *Orchidaceae* (orchid family) and *Potamogetonaceae* (pondweed family) 13 each, *Liliaceae* (lily family) 11, *Polypodiaceae* (fern family) and *Gentianaceae* (gentian family) 10 each.

It is perhaps significant that sedges and other grass-like plants make up a total of no less than 181 species or almost one-fourth of the entire flora of vascular plants.

It is of course not possible in a summary discussion of the flora of such a vast land area as that of the Northwest Territories, embracing over 20 parallels of latitude and 20 degrees of longitude, to enter into a detailed discussion of the plant life and problems of affinity and distribution. It must suffice here to mention briefly the principal life zones and plant associations.

THE ARCTIC ZONE

The Arctic zone in Canada comprises the Arctic archipelago and all the treeless country lying north of the transcontinental coniferous forest, in America generally known as the "barren grounds" or in recent literature sometimes as the "northern plains." In Eurasia the "barren grounds" are known as "tundra"

from the Finnish word "tundren" meaning a treeless, rolling plain. The southern boundary of the Arctic zone was formerly taken to be the northern limit of trees and it was thought that this roughly coincided with the course of the 50° F. isotherm for the warmest month of the year. Recent discoveries, however, have shown that at least in Canada large parts of the "barren grounds" are treeless not because of an inadequate summer temperature, but more likely because of insufficient precipitation during summer coupled with extreme dryness of the air during winter, and that they really should be classified as true prairies or steppes, and, therefore, strictly speaking, should not be included in the Arctic zone.

Contrary to popular conception land surfaces even in high latitudes in the northern hemisphere are not entirely wanting in plant cover. The ground at least at sea level is not perpetually covered by ice and snow. Vegetation to be sure is much affected by the severe conditions under which it must exist, but the shortness of the growing season, deficiency of soil and precipitation perhaps have a more marked effect on plant life than the relative lowness of the actual air temperatures. In the northern hemisphere, particularly in the central parts of large continents or islands, the precipitation in summer and

The Blue Hirsute Anemone (*Anemone ludoviciana*) Commonly Known as "Wild Crocus"

winter is very light, totalling under seven inches for the year. The winter snowfall is light, and frequent gales sweep it off the level ground exposing the plant cover to the detrimental drying effect of the air. So light indeed is the rainfall during the growing season that, were it not for the fact that the ground remains perpetually frozen a few inches below the surface thus preventing the surface water from penetrating to levels beyond the reach of the roots, most of the Arctic zone would be a lifeless desert.

Thus from Ellesmere island and Greenland, north of the 80th parallel of latitude, we know of no fewer than 76 species of flowering plants and ferns, and

even there herbaceous vegetation occurs so abundantly that it provides pasture for such large herbivorous animals as musk-ox and caribou.

Some of the principal characteristics of Arctic plants are their ability to withstand drought and the amazing short time they require to awaken from the dormant state of the long Arctic winter, come to bloom, reproduce and mature seed, and prepare again for the next winter. The small, purple-flowered saxifrage (*Saxifraga oppositifolia*), the yellow whitlow grass (*Draba alpina*) and the yellow Iceland poppy (*Papaver radicatum*) require only one month to commence growth, flower, and mature seed. At the mouth of the Mackenzie river the so-called "wild crocus" (*Anemone* or *Pulsatilla ludoviciana*) had commenced growth on May 15 while a thin crust of snow still covered last year's withered leaves. On May 25, when the ground had dried, the large, bluish flowers appeared while the new foliage was still undeveloped. On June 25 some of the seeds had already been dropped.

In August most of the Arctic plants have completed their season's life-cycle. While the seeds are maturing, new leaf buds and flower buds are developed near the surface of the soil, well hidden amongst the old leaves, and food is stored up in the subterranean stem and root system in preparation for next season's growth.

Plant life in the Arctic resembles in many ways that found in the alpine regions of high mountains in more temperate zones, and a large number of species are indeed common to the Arctic zone and the Cordilleran peaks more than a thousand miles to the south.

In the Arctic, plants make up for the short season of growth by the continuous daylight and the consequent steady radiation of heat from the ground. Because of absorption of heat by the dark-coloured soil and its vegetation the actual temperature in the surface soil and in the air surrounding the growing plant has been found to be as much as 25 or even 40 degrees higher than the actual temperature of the air. In northern Greenland (latitude 82° 29′) during the month of May when the air temperature still remained 10° F., Thorild Wulff, the Swedish botanist, measured a temperature of 38° F. among the withered leaves of a tuft of saxifrage, and even 50° F. in brown cushions of moss.

Characteristic of the Arctic zone is, of course, the absence of trees. A number of species of ligneous or woody plants, such as willows, alder, and various kinds of berry bushes and heather are found but even these, north of the tree-line, become low and dwarfed and are generally restricted to places where snow cover is assured during winter. On the mainland, some distance from the seashore, some of these still form the dominating feature of the vegetation, but off the mainland this group rapidly dwindles. The willows now all become low and trailing and the berry bushes disappear entirely. On the southern islands of the archipelago a few of the latter still are to be found, but they no longer produce fruit and farther north they drop out entirely. On Melville island, credited with a flora of 86 species of vascular plants, are found but two woody plants—the prostrate circumpolar Arctic willow (*Salix arctica*) and the equally widely distributed white heather (*Cassiope tetragona.*)

Among the herbs of the Arctic zone there are no climbing plants, none that are poisonous, nor any that are protected by spines or thorns. Very few are annuals and as a general rule Arctic plants of all species depend only to a limited extent for their propagation upon seed, protecting themselves against unfavourable seasons by various means of vegetative reproduction. One of these means is wintering buds which are not buried in the soil but are situated close to the surface and are well protected by withered leaves. Most of the herbs are caespitose with numerous leafy shoots, forming dense cushions or rosettes. In most species a profuse branching is the rule.

The country north of Great Bear lake and west of Coppermine river is a rolling plain which in few places reaches elevations above 1,000 feet. The bedrock in most places is well covered by glacial till. Here we find wide areas

covered with heath in which the chief components are the ground birch (*Betula glandulosa*), Labrador tea (*Ledum decumbens*), bearberry (*Arctostaphylos alpina*), the white heather (*Cassiope tetragona*), bilberry (*Vaccinium uliginosum* var. *alpinum*) and the alpine cranberry (*V. Vitis-Idaea*). The ubiquitous tussocks formed by the pretty white-headed cotton grasses (*Eriophorum vaginatum* and other species) and by various kinds of sedges, commonly known in the North as "niggerheads" or "têtes des femmes" are characteristic of the northern heaths and moors. A comparatively small number of perennial herbaceous plants are present everywhere in the heath. Most interesting, perhaps, are the yellow and pink-spiked louseworts (*Pedicularis labradorica, P. lanata* and *P. arctica*), which, although they themselves possess green foliage, are parasitic, living on the roots of the heath bushes. For a short time during early spring the dull, green tint of the Arctic heaths and moors is brightened by the appearance of the sky-blue, hyacinth-like spikes of the Arctic lupine (*Lupinus nootkatensis*), by the yellow and purple loco-weed (*Oxytropis*) and the purple, sweet-scented Lapland rhododendron (*Rhododendron lapponicum*). These flowers last but a short time and for the rest of the year these plains present a dreary aspect.

Stunted Spruce North of Great Bear Lake
Owing to the prevailing wind the white spruce in the foreground has developed with its branches all flat against the ground.

The ground under and between the stems of the dwarf bushes is everywhere covered by a dense carpet of lichens and mosses into which the foot of the traveller sinks ankle deep at every step, thus making travelling on foot exceedingly wearisome. Along lake borders and streams where the ground is well drained and watered and on sloping hillsides where great snowdrifts accumulate during winter, thus ensuring a constant water supply throughout the growing season, a more luxuriant vegetation is generally encountered. Here willow and alder bushes, sometimes 6 to 8 feet high, form dense thickets. These are the "oases" of the Arctic "barrens," for, here, protected and sheltered by the willows are gaily coloured flower mats composed of yellow arnica, purple and rose-

coloured Indian paint brush (*Castilleja pallida*), and the exquisite little Lapland lousewort (*Pedicularis lapponica*) the fragrance of which suggests lilies of the valley. With these also grow delicate white wintergreens (*Pirola grandiflora* and *P. secunda*), pink spiked bistortas (*Polygonum Bistorta* and *P. viviparum*), the root of which is eaten by the Eskimos, half-a-dozen species of buttercups, and many others. Even as far north as the shores of the Arctic ocean may be found a small orchid (*Habenaria obtusata*).

In the bottom lands, between the low hills, are found extensive meadows that may well deserve the name of prairies. They are of greatest extent in the low, alluvial plains bordering the Arctic ocean, west of the Anderson river, and in central Keewatin. These plains were perhaps the last places to become available to plant life upon the recession of the Keewatin ice-sheet and the subsequent general emergence of land from the sea and the draining of former lakes. The meadows and prairies may be considered to be in a transitional stage only, since indeed in many places they show evidence of being in the process of being succeeded by heath.

The flora of the Arctic meadows and prairies, like that of the heaths and moors, is poor in species but rich in individuals. Grasses and sedges, of course, predominate, making up 75 per cent or more of the cover. They are rather short and seldom grow more than knee-high. While less succulent than those of southern latitudes, analyses have shown them to have a higher food value per unit of weight.

On sandy ridges throughout the "barren grounds" we find little green oases of rank grasses mixed with yellow Arctic poppy, purple Arctic wall-flower (*Erysimum Pallassii*), dandelion, blue jacob's ladder (*Polemonium boreale*), forget-me-not (only in the western Arctic) sages (*Artemisia*) and many others. These oases have been referred to poetically as "gopher gardens." The plants found here are a dung-loving species that, on the well-drained, highly manured soil of the honeycombed burrows of the Parry Ground Squirrel (*Citellus parryi*) —in the north known as "ground squirrel"—grow more luxuriantly than elsewhere. The seeds of some of these and a number of others are "harvested" by the squirrels and in this way, and also because some adhere to their fur, are dispersed by them from place to place.

Of greatest diversity is the flora of rocky places, particularly the acid, ancient rocks of the Laurentian shield east of the Coppermine river. The rocky plateaus and ridges almost deserve the appellation of "barrens" for they have been left by the glaciers completely denuded of soil. But even they are not completely devoid of vegetation, for the rock surface nearly everywhere is covered by black, brown, and grey species of rock lichens *Gyrophora* (rock tripe), and others that lend a sombre and rather depressing hue to the landscape. Here and there where boulders or erratics, left by the glaciers, offer a perching place for snowy owls, hawks or other birds, the dung-loving, bright yellow or vermilion lichen *Xantheria* grows in profusion.

In crevices of the rock we find during early summer a number of variously coloured rock plants among which the saxifrages dominate. Here we also find the three only Arctic ferns—the tiny, delicate *Woodsia glabella*, *W. ilvensis*, and the sweet-scented shield fern (*Dryopteris fragrans*).

On the rocky slopes where more soil has accumulated we find a number of other species. The white-flowered mountain aven (*Dryas*) common throughout the north, is particularly at home here. It forms large, flat cushions, often many feet in diameter and sometimes almost excludes all other species. With it we often find large mats of crowberry (*Empetrum*) and clumps of the purple, broadleaved *Epilobium latifolium* or *Hedysarum Mackenzii* whose showy purple flowers are scented like sweet clover. Other colours are added by the lilac-flowered vetch *Astragalus alpinus* and by yellow arnica and loco-weed (*Oxytropis*).

Mountains high enough to harbour a true alpine flora are few in the Northwest Territories. The Horn mountains, Norman and Franklin ranges that flank the east bank of the Mackenzie between Simpson and Good Hope are barely high enough to offer true alpine conditions. No botanist has ever visited them but seen from an aeroplane their limestone plateaus appear singularly barren of vegetation.

High mountains are, of course, found west of the Mackenzie but very little is as yet known of their flora. A few excursions made by the writer to mountains west of the Mackenzie delta, however, generously repaid the effort by a rich harvest of rare and unexpected finds thus intimating to the botanist the treasures that here await future botanical collectors.

THE HUDSONIAN ZONE

The Hudsonian zone embraces practically all of the forested part of the Northwest Territories or roughly speaking the southwestern half of the mainland, since the tree-line approximately bisects the land diagonally from the west shore of Hudson bay, near the 60th parallel of latitude to the mouth of the Mackenzie river in latitude 69°. Its northern boundary towards the Arctic Zone, however, is not well defined since tongues and detached, isolated "islands" of wooded country, chiefly along rivers and streams are often found in favoured or sheltered places far north of the continuous coniferous forest. In the same manner treeless areas are found well within the forested area. The overlap is even more marked when we consider the non-arborescent flora.

The southern boundary of the Hudsonian Zone in most places is to be sought well south of the 60th parallel and only in the valleys of the upper Mackenzie, the Slave, and the Liard rivers does the Canadian Zone enter the Territories.

The great majority of plants inhabiting the Hudsonian zone are not peculiar to this zone but are found in suitable places to the south and north as well. A large number are widely distributed, circumpolar species common to northern Europe and Asia as well.

Characteristic of the Hudsonian zone is the wide belt of more or less stunted coniferous forest composed of white and black spruce. The former generally occupies the higher ground while the latter (*Picea mariana*) together with the tamarack (*Larix laricina*) dominates the muskegs and the bogs. The white spruce (*Picea glauca*) is by far the most important timber tree of the region. On the alluvial bottom lands of river valleys and in protected, favourably exposed slopes, it grows into a stately tree that even north of the Arctic Circle in the Mackenzie valley and delta may reach a height well over 100 feet and attain a diameter of over 24 inches.

Other trees of the Hudsonian zone are balsam poplar (*Populus tacamahaca*), aspen (*P. tremuloides*) and canoe or paper birch (*Betula papyrifera* var. *neoalaskana*). Willows grow in great profusion as undergrowth in the coniferous forest and along river banks. Although more than a score of species are found here, but one (*Salix interior*) attains tree size.

On the east bank of Mackenzie river the spruce forest almost reaches the 69th parallel of latitude. In this latitude the forest, which up to this parallel covers the immediate river bank and is sheltered from the cold and dry east winds by the Caribou hills, terminates suddenly in a well marked line when the hills become lower. Beyond this line stunted and scrubby spruces may be found almost to the shores of the Arctic ocean, but they no longer resemble trees but grow as low, dense mats, seldom reaching more than knee high.

Among the dozen or so low, woody plants of the Hudsonian zone that follow the spruce to this high latitude may be mentioned the creeping form of the common juniper (*Juniperus communis*).

Peculiar to the Hudsonian zone and deserving of special notice is the type of bog known as muskeg in which black spruce and tamarack are the dominating trees. The broad-leaved Labrador tea with leather-leaf (*Chamaedaphne caly-*

culata) are the shrubs most frequently met with and bog rosemary (*Andromeda polifolia*), mountain cranberry (*Vaccinium Vitis-Idaea*) and other dwarf shrubs are also common, but because of their smaller size less conspicuous. A thick mat chiefly consisting of peat moss and other mesophytic woodland mosses makes up the mass of the ground cover almost to the exclusion of herbaceous plants. The muskeg forests occupy most of the level, poorly drained ground in the Hudsonian zone, particularly within the limits of the Archaean rocks, and this region, because it almost entirely lacks green herbage suitable for pasture as far as herbivorous animals are concerned is almost a veritable desert, unproductive as a fur and game producer.

Muskeg Vegetation

As in the Arctic zone the most luxuriant vegetation is found along the banks of lakes and water courses. During early summer, shortly after the recession of the spring floods, the alluvial banks of the Mackenzie and other rivers of the Northwest Territories exhibit a varied show of gay, multi-coloured flowers. Worthy of note are the pink and purplish flowered hedysarums—of which *H. boreale* has an edible root—yellow cinquefoil (*Potentilla*), and blue gentian, that with clumps of the pretty white-flowered grass of parnassus (*Parnassia palustris* and other species) and the northern strawberry (*Fragaria glauca*) enliven the banks above the water's edge. From the deck of the river steamer the traveller may get glimpses of thickets of wild rose (*Rosa acicularis*) or the white-flowered service berry (*Amelanchier*), or even yellow and purple moccasin flowers (*Cypripedium passerinum* and *C. guttatum*).

In the alluvial river soils the balsam poplar attains its greatest perfection in these regions. During the early spring the young leaves of this species and those of the scented willow (*Salix alaxensis*) send out an exquisite perfume familiar to all travellers of the north.

THE CANADIAN ZONE

The Canadian zone barely enters the Northwest Territories along the valleys of the Slave, the upper Mackenzie, and the Liard rivers. On the Mackenzie it extends north approximately to the 65th parallel of latitude.

Characteristic of the flora of the Canadian zone in the Northwest Territories is the jack or Banksian pine (*Pinus Banksiana*). It is found chiefly in sandy soils where it forms almost pure stands. It attains a diameter of from 12 to 18 inches but does not become very tall.

Of the 74 different families represented in the flora of the Northwest Territories no fewer than 13 are found in the Canadian zone only, representing the most southern or temperate element in the flora. Numerically this element, however is not large, since most of the thirteen families are represented by one or two species only. Some of these that are characteristic of the Canadian zone are the cattail (*Typha latifolia*), arrowhead (*Sagittaria cuneata*), iris, nettle (*Urtica gracilis*), pitcher plant (*Sarracenia purpurea*), (*Geranium Bicknellii*), touch-me-not (*Impatiens Noli-tangere*), mountain maple (*Acer spicatum*), Indian hemp (*Apocynum androsaemifolium*), (*Phacelia Franklinii*), species of the mint family (*Lobelia Kalmii*), and muskroot (*Adoxa Moschatellina*).

FLORA OF FRESHWATER LAKES

Of particular interest to the plant geographer is the flora of the hundreds of thousands of lakes that dot the surface of the Northwest Territories. Although without exception all aquatic vascular plants in their main distribution are of a southern or temperate type, a surprisingly large number of species have reached far into the Arctic zone. Most of the aquatic plants near their northern limit, however, are unable to reproduce by seed, but maintain themselves successfully chiefly through the production of winter buds. Different views have been advanced to explain their present distribution in the Arctic. Some maintain that they must be considered as having survived from a warmer post-glacial period while others hold that the seeds of aquatic plants are more readily dispersed by birds than those of terrestrial plants, and that these plants are carried from lake to lake by aquatic birds during spring migration.

The waters of the large northern lakes are generally cold and the richest aquatic flora is found in small, shallow lakes. In shallow lakes and small streams in early spring, the sun's rays penetrate the ice, although this is often frozen to the bottom, and are absorbed by the dark mud or black mosses of the bottom, causing the ice to melt from below. For this reason the small lakes open up much earlier than the large ones. On Great Bear lake, when it was still possible to travel with sledges and dogs on the ice of the main lake, the writer in June, 1928, found the water of small ponds and streams warm enough for comfortable bathing. Because of the heat-retaining quality of water the growing season of aquatic plants is extended for a month or longer after the terrestrial plants have ceased their activities because of night frosts.

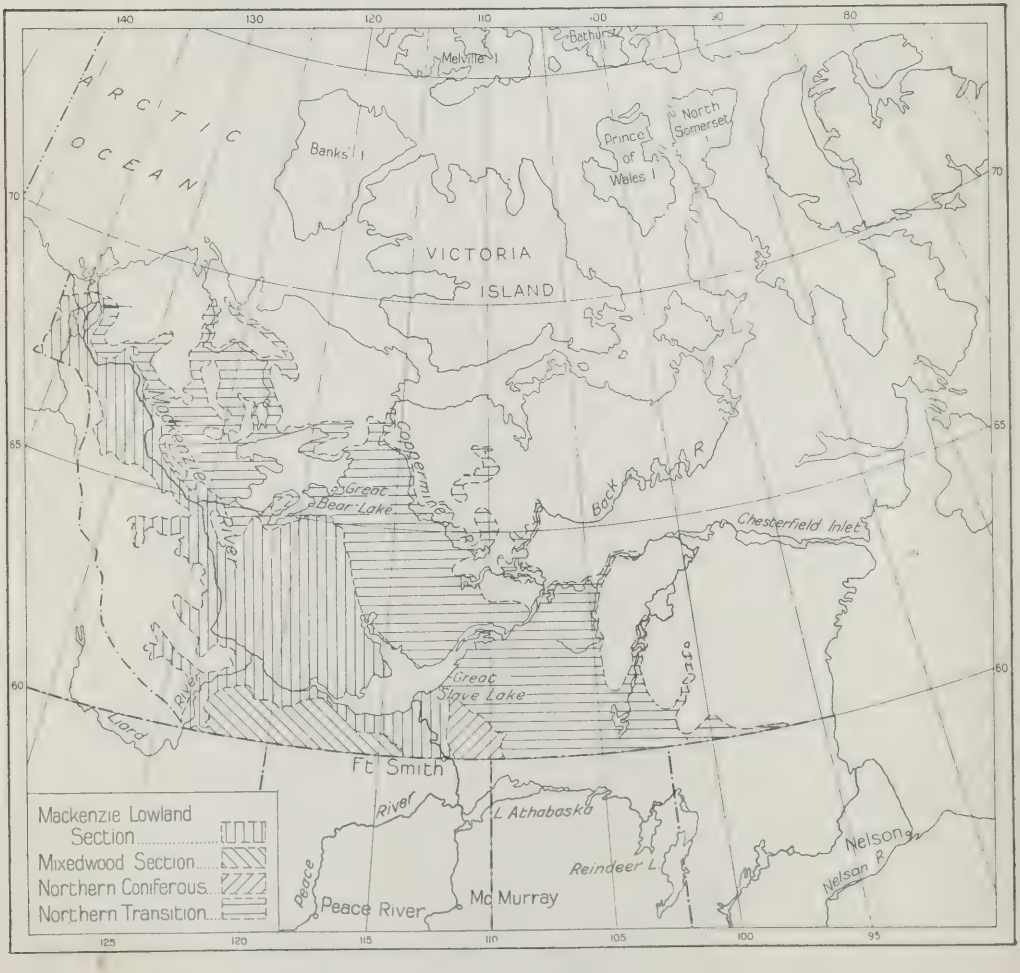
Most aquatic plants have a very general distribution and most of the species that occur in the Northwest Territories are circumpolar. For the same reason the flora of small lakes and streams throughout the Canadian, Hudsonian and Arctic zones do not show a very marked difference except that the number of species becomes gradually reduced as we proceed north. Recent discoveries in the Mackenzie District have brought some very remarkable range extensions, but since most non-botanical collectors have neglected the aquatic plants it may be expected that future exploration will disclose a more general northern distribution. Many species of aquatic plants have recently been discovered as far north as the shores of the Arctic ocean. Some of the better known or most conspicuous of these are the yellow water lily (*Nymphozanthus variegatus*) the roots of which with the white-flowered water arum (*Calla palustris*) are among

the choice foods of beaver and muskrat. Then there is the tiny duckweed (*Lemna trisulca*), bottle brush (*Hippuris vulgaris*), water millfoil (*Myriophyllum*) and a dozen or more species of pondweeds (*Potamogeton*) the winter buds and rootstocks of which furnish an important part of the winter food of muskrats. There is also the water ranuncle (*Batrachium*) whose tiny white flowers unfold under water, and many others. The plants inhabiting the marshes are in much the same category as the truly aquatic plants. Here we find the pretty yellow marsh marigold (*Caltha palustris*), buckbean (*Menyanthes trifoliata*) and the sweet-scented, white (*Ranunculus Pallassii*) which is one of the very few marsh or aquatic plants found in the Arctic zone only.

The larger lakes, as stated, as a rule are too cold and deep for most vascular aquatic plants. They, however, possess a rich flora of mico-organisms such as diatoms, flagellates, and others of which our present knowledge is very imperfect. Different species of these microscopic plants impart a different colour to the waters of the lakes. This is best seen from the air, where it is at once noticeable that, apart from the difference in colour due to the depth of the waters and the nature of the bottom, the water itself in no two lakes is exactly alike.

FORESTS*

The forests of the Mackenzie District are chiefly valuable as the source of building materials and of fuel for the use of the local population, and as a favourable environment for fur-bearing and game animals. Up to the present time difficulties of transportation have prevented any attempt to establish forest operations on a commercial scale; and, so far as is known, there are no forests suitable for such exploitation in the future. On the other hand, there should be no difficulty in securing supplies of forest products adequate to the needs of the residents in perpetuity, provided that reasonable protection from forest fires is afforded.



FOREST MAP OF THE NORTHWEST TERRITORIES

* *Dominion Forest Service, Department of Mines and Resources.*

All forested lands within the district are included in the Boreal forest region, which comprises the forests of the northern part of North America. Of the numerous subdivisions, or sections, of this region, four are found in the district. Two of these, the Mixedwood and Northern Coniferous sections, are represented by relatively small areas adjacent to the boundaries of Alberta and western Saskatchewan, and the other two, the Mackenzie Lowland and Northern Transition sections, occupy all the rest of the forested area. The northeastern part of the district is open tundra, and there is an extensive treeless area along the Yukon boundary where the approaches to the Mackenzie mountains rise above the timber-line.

The *Mixedwood* section occupies a limited area along the Alberta boundary south of the west end of Great Slave lake and Mackenzie river. It is an extension of the most important forest section of the Prairie Provinces, and is believed to afford the best growing conditions for forest trees to be found in the district. The topography is that of a low plateau of moderately uneven surface, terminated by an escarpment to the north and east. The soils are of glacial origin, are of considerable depth, and are usually well drained. On the upper levels there are extensive sphagnum swamps where drainage is lacking. Aspen and white spruce are the typical trees of the section, and are accompanied by balsam poplar, white birch, tamarack, black spruce, and jack pine. The first three species mentioned dominate the better sites, black spruce and tamarack occupy the timbered muskegs, and jack pine is found on sandy soils. Such information as is available suggests that through the action of recurrent forest fires the representation of the poplars on the better sites has been increased at the expense of white spruce.

The *Northern Coniferous* section, occupies a small triangle based on the northern provincial boundary and lying immediately to the east of Fort Smith. It falls within the margin of the Precambrian Shield, and is characterized by shallow soils and poor drainage. Black spruce, the principal tree species, is found in mixture with jack pine on low ridges where drainage is good, and with tamarack in the lower and wetter areas. Poplar and white spruce are generally restricted to the vicinity of watercourses, where there are small patches of good alluvial soil.

The *Mackenzie Lowlands* section, is the most important forest area of the district. As its name implies, it occupies the low-lying plains in the basin of Mackenzie river, and embraces the lower portions of its main tributaries, including Liard, Peel, and Great Bear rivers. It is an area of numerous lakes and swamps, and the general flatness is broken in places by a few low isolated ranges of undulating hills. The soil is of glacial, alluvial, and lacustrine origin, and is generally of good depth. Although the soil is never free from frost, except to a depth of a few feet below the surface, and the growing season is short, trees grow to fairly good size owing to the extremely long daily period of sunlight in summer. White spruce is probably the natural dominant species, but forest fires have increased the proportions of aspen, balsam poplar, and white birch. In the same way jack pine has gained control of sandy areas. Well developed stands of balsam poplar are characteristic of well-drained alluvial soils along the river banks, and black spruce and tamarack occupy those swamps which are not too wet to support tree growth.

The *Northern Transition* section lies to the north and east of a line passing approximately from the mouth of Mackenzie river through Great Bear and Great Slave lakes. Unfavourable climatic conditions, acting in conjunction with the thin soils and poor drainage characteristic of the Precambrian Shield, reduce the number, distribution, and size of tree species. Open swamps and tundra formations are intermixed with stunted forests, and the trees become confined to narrow fringes along the streams and finally disappear.

The principal trees are the two spruces, birch, and tamarack, of which the last-mentioned species tends to dominate the outer fringes of the forest. Jack pine, aspen, and balsam poplar are found in a stunted form along the south-western margin, but are of very little importance.

Satisfactory estimates of the areas and volumes of the various forest types within the district are lacking, but more definite information becomes available periodically as the area covered by aerial photographs is extended. It is already known that the forests are not of sufficient value to justify heavy expenditures in mapping and describing them, but the air photographs, taken primarily for other purposes, will give all the information needed for their administration.

On account of the cost of transporting materials into the district, much of the lumber used is of local manufacture. Small sawmills are operated at various points on Slave river, Great Slave lake, and Mackenzie river. Most of these mills are equipped with planers. Nearly all the lumber sawn is of white spruce, and the wood of this species is used for all parts of buildings from floor to roof. It is also in demand for boat-building, and for nearly every other purpose for which lumber is used.

Tamarack is valued for its toughness and durability for certain parts of boats, and also makes excellent ground sills for buildings. White birch is used by the natives for snowshoe frames and for framing canoes; although its bark has been largely superseded by canvas for canoe coverings. Black spruce is occasionally sawn in small quantities, and both this species and jack pine are used for the construction of log cabins.

All species are used for fuel, and the supplying of fuel-wood is the most important function of the forests of the district. The fuel supply is augmented to an important degree by the large quantity of driftwood which annually finds its way into Mackenzie river. The driftwood originates, principally, through the undermining of the forested banks of tributary streams, and it is eagerly sought after, particularly by inhabitants of the lower reaches of the main river.

It is difficult to assess the value of the forests as a shelter for game and fur-bearers. However, it is known that many valuable species make their homes in wooded country. Since the fur trade has been, and will continue to be, the main support of the native population, and since forest-dwelling animals supply the Indian with meat, the forests must be protected from wanton destruction for reasons additional to those connected with the need for future supplies of wood.

GEOLOGY AND PHYSIOGRAPHY*

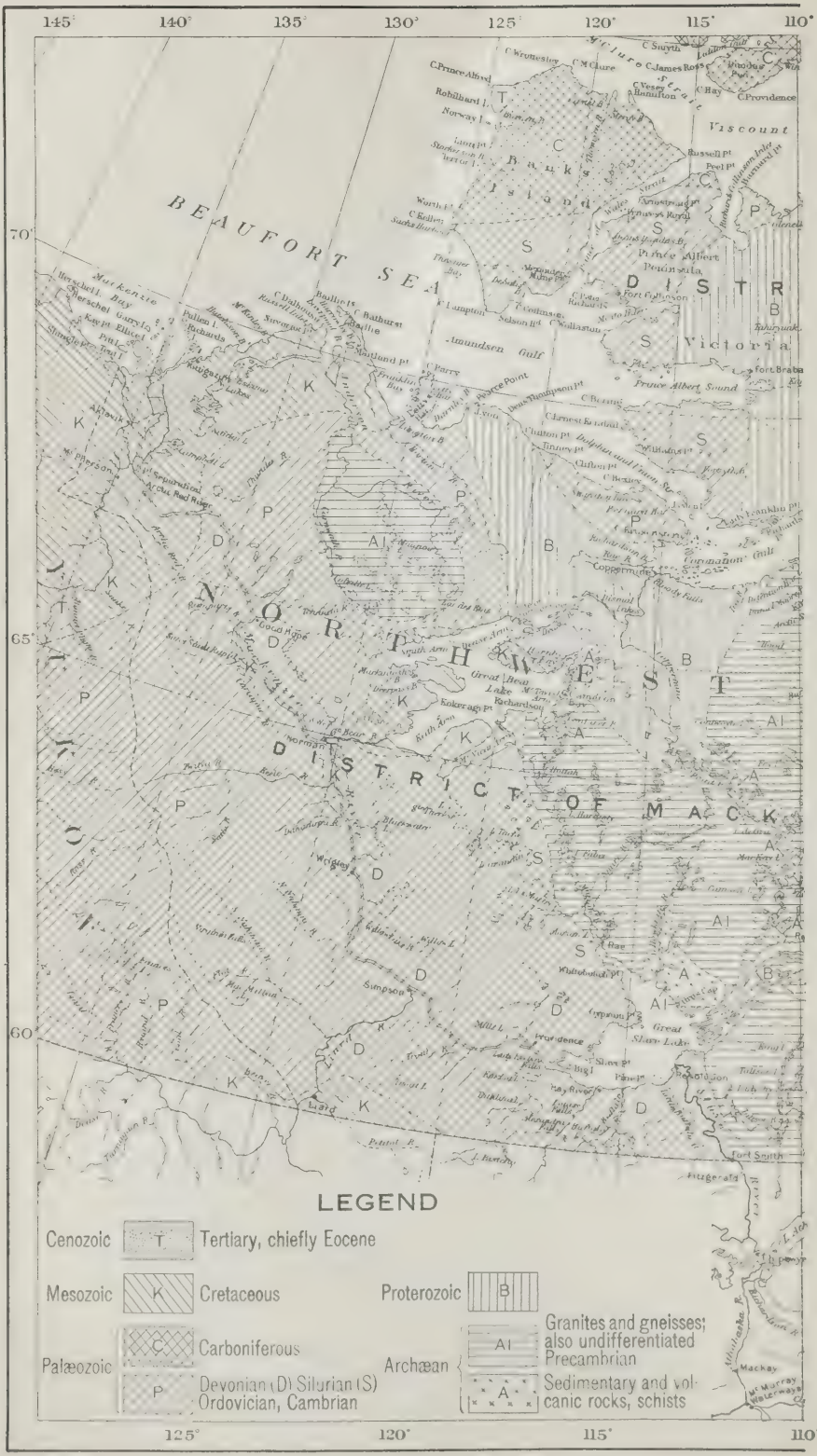
The part of the Northwest Territories included in this section is made up of portions of four of the six physiographic provinces into which Canada, on the basis of its topography and geology, naturally falls. To the north, Banks island and Victoria island form part of the Arctic archipelago. On the west, the Mackenzie mountains are the northeastern portion of the great Cordilleran region which makes up British Columbia and Yukon Territory. The belt bordering Mackenzie river is the northern prolongation of the interior plains of Central Canada; though dominantly a lowland region, it includes a chain of mountains known as the Franklin range lying with several other ranges and hills between Mackenzie river and Great Bear lake. To the east of this belt and extending over to Hudson bay is a broad zone belonging to the Canadian Shield, that vast plateau region surrounding Hudson bay and comprising nearly two-thirds of Canada. The rocks which compose it are of Precambrian age but in places, particularly along the Arctic coast on the border of the Shield, considerable areas of the Precambrian rocks are concealed by a capping of younger sediments. The geology of each of these four divisions will be discussed separately but in order to give a general picture of the economic possibilities of the region as a whole, the known mineral occurrences which may have economic importance will be discussed together.

Most of the information concerning the geology of this vast region is from reconnaissance surveys by officers of the Geological Survey of Canada. Geological notes by explorers and by mining engineers and prospectors who have visited parts of the region have also contributed to the knowledge regarding its rocks and its mineral resources. The early information was summarized by G. M. Dawson, in the Annual Report of the Geological Survey for 1886, Volume II, Part R. For more recent information concerning sections which have been studied since that time, numerous later reports published by the Geological Survey and the report of the Canadian Arctic Expedition 1913-18 are the main sources.

Since the rocks of the region range in age from the very earliest period of the earth's history up to Recent, the following table of the divisions of geological time is given to serve as a guide for the succeeding descriptions:—

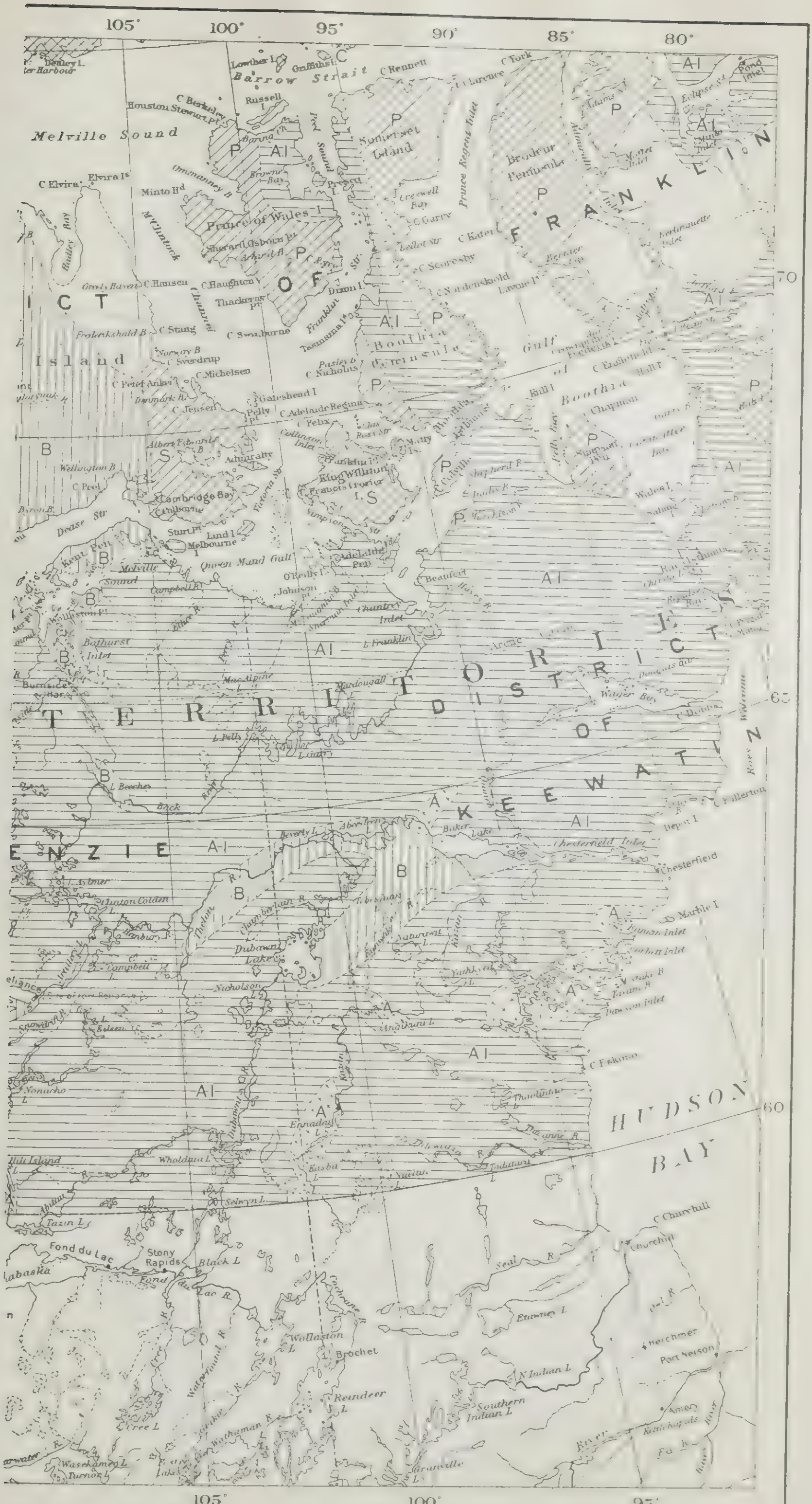
Eras	Sub-Eras	Periods
Cenozoic	Quaternary	Recent
		Pleistocene
	Tertiary	Pliocene
		Miocene
		Oligocene
		Eocene
Mesozoic		Cretaceous
		Jurassic
		Triassic
Palaeozoic	Carboniferous	Permian
		Pennsylvanian
		Mississippian
		Devonian
		Silurian
		Ordovician
		Cambrian
Proterozoic (late Precambrian)		
Archaean (early Precambrian)		

* Prepared by F. J. Alcock, Ph.D., Geological Survey, Department of Mines and Resources.



GEOLOGICAL MAP OF THE

Much of the country is underlain



Northwest Territories
by rocks of Precambrian age.

CANADIAN SHIELD

The greater part of the territory under discussion lies within the Canadian or Precambrian Shield. It is a region of comparatively low relief rising gradually from the Arctic ocean on the north and from Hudson bay on the east to elevations around 1,500 feet in its central part east of Great Bear and Great Slave lakes. In detail the topography is hummocky, consisting of ridges and hills separated by depressions which are commonly occupied by lakes or muskegs. The numerous lakes are of all sizes and shapes with very irregular shorelines and many islands. In places the country presents the appearance of a drowned topography with only the ridges projecting through. Over wide areas the land only here and there rises as much as one hundred feet above the level of the immediately adjacent lakes. In other places, as for example, at the east end of Great Slave lake, the local differences of relief amount to more than eight hundred feet. The lakes owe their origin to the work of the continental ice sheet which spread over the region during the Pleistocene. By the excavation of new channels and by the damming of old ones through the irregular deposition of glacial debris, the drainage pattern of pre-glacial days was completely disorganized.

The rocks of the Shield are mainly of Precambrian age and form a continental mass which in Precambrian times extended out in all directions beyond the present limits of the Shield. The low relief of the region was produced by long continued erosion in late Precambrian time, which eventually levelled the mountain belts which had earlier been produced by folding. During the Palaeozoic and Mesozoic eras this region of low relief was many times flooded at least partially by seas which advanced over its surface and later retreated. The sediments which accumulated in these seas were largely swept away by later erosion when, during the Tertiary, the region stood above the sea. Though at various times, from the close of the Proterozoic onward, the region has undergone vertical movements allowing it to be periodically flooded, it has through all this time been a very stable mass unaffected by folding or mountain-building movements.

Precambrian time was very long and is commonly divided into two eras, an early one known as the Archaean and a later called the Proterozoic. Since this twofold division is based on rock formations in Eastern Canada it is difficult in some places in the Northwest to say to which of these two time-divisions certain rocks should be assigned. The oldest record we have of Archaean time is the accumulation of sedimentary and volcanic rocks. The former consisted originally of conglomerates, sandstones, shales, and limestone and the latter of flow rocks and fragmental tuffs and breccias. All these rocks have been extensively intruded by granite, highly altered, and in places rendered schistose. The limestone members are commonly altered to a large extent to secondary silicate rocks. The shales have gone over into argillites and mica schists, the sandstones into quartzites and paragneisses. The most highly altered rocks are the schists and gneisses; these are commonly marked by the presence of abundant garnet crystals. Volcanic rocks, though present in certain areas, are much less abundant in Northwestern Canada than in the rocks of supposedly corresponding age farther east towards the southern margin of the Shield. They include the types commonly known as greenstones, consisting of altered basic lavas, and in places these are altered to schists which along granite contacts are commonly hornblendic. These early rocks have been assigned various names in different areas. Between lake Athabaska and Great Slave lake they have been described under the term Tazin series; in the Great Slave Lake-Coppermine River area they are called the Point Lake-Wilson Island group; east of Great Bear lake the names applied to corresponding rocks are Cameron Bay and Echo Bay groups. Whether all these groups and series are of contemporaneous age is not known.

In Archaean time the early sediments and volcanic rocks were intruded by granite and related rocks such as granodiorite, quartz diorite, and pegmatite. Over wide areas the intrusions took the form of intimate injection along the bedding planes of the sediments giving rise to hybrid rocks consisting of mixtures of sedimentary and intrusive material in every possible proportion. In places the sediments were apparently replaced by granitic solutions so that the resulting rock has the appearance of a banded sediment but the composition and texture of a granite. In still other places the intrusive granite shows cross-cutting relations to the older rocks and has produced in them abundant contact metamorphic effects. The intrusion of the granite was accompanied by mountain building which was followed by erosion and resulting sedimentation. This revolution marks the close of the Archaean era.

Sedimentary Gneiss, North Shore of McLeod Bay, Great Slave Lake

During the Proterozoic at least two series of sediments accumulated in each of several widely separated areas. Whether the older set of any one area can be correlated directly with the older of any or all of the other areas is not known. North of lake Athabaska a white and red quartzite belonging to the older groups overlies unconformably the sediments of the Tazin series. It has a basal conglomerate containing large boulders of granite. Along the east arm of Great Slave lake a synclinorium about 150 miles long consists of conglomerate, arkose, sandstone, quartzite, shale, slate, oolitic iron formation, dolomite, breccia, basalt, andesite, trachyte, rhyolite porphyry, and tuff. Two or more series of strata may be represented in this group which is known as the Great Slave group. It rests unconformably on granite. Along the Arctic coast, between Parry peninsula and Bathurst inlet, three formations of probable early Proterozoic age rest on Archaean granite. The oldest is the Epworth dolomite best developed about Port Epworth harbour where it rests with a basal conglomerate on granite. The second formation is the Kanuyak consisting of calcareous tuff and tuff-conglomerate. The formation occurs on the islands of Bathurst inlet and on one it rests with structural unconformity upon the Epworth dolomite. The upper formation is the Goulburn quartzites which have a thickness of over 4,000 feet. It has not been found in contact with either of the other formations

but several beds contain rounded fragments apparently derived from the Epworth dolomite and the Kanuyak formation. The early Proterozoic was apparently marked by disturbances and vertical movements. North of lake Athabaska, invasions of basic rocks, chiefly gabbro and norite, took place on a large scale during the latter part of the early Proterozoic and these were followed by granite intrusions which are important because of the gold they brought with them.

Late Proterozoic time was marked by the accumulation of a thick series of clastic sediments in various parts of the region and by volcanic activity. In the Arctic region these rocks are known as the Coppermine River series; in the Great Slave Lake region, they form the Et-Then series; in the Lake Athabaska-Dubawnt River region they are referred to as the Athabaska series.

Coppermine River at the Outlet of Lac de Gras

The rocks of the Coppermine River series occur along Coppermine river and farther east on Bathurst inlet. In the former area the estimated thickness of the series is about 48,000 feet. The lower 14,000 feet consists chiefly of flows of basaltic lava with thin interbeds of conglomerate. These are succeeded by dark red to brown sandy shales which are in turn followed by fine to medium-grained red to brown sandstones. The upper 11,000 feet consists of red sandstones, shale and limestone intruded by sills of diabase. From the Coppermine river eastward to Bathurst inlet grey shales and sandstones occur underlying sills of diabase. In Bathurst inlet only the lower part of the series remains; it is represented by 900 feet of amygdaloidal basalt with a few thin interbeds of tuffaceous conglomerates and ash. Farther east on Kent peninsula are sandstones intruded by sills and dykes of diabase. The rocks nearly everywhere have low dips of an average of about 10 degrees.

The Et-Then series occurs in a number of isolated areas north of Great Slave lake. It consists of conglomerate sandstone, and quartzite, resting unconformably on the members of the Great Slave group, the granite, and the Archaean sediments. Over wide areas the beds have low dips of from 5 to 20 degrees but near faults dips vary up to 70 degrees. At two localities amygdaloidal lava is interbedded with conglomerate.

The Athabaska series has its main development south of lake Athabaska but a few areas north of the lake and a large one in the Dubawnt River country are covered by beds which have been mapped as the same series. The beds

consist of white sandstones, buff and reddish sandstone, arkose, and conglomerates, and in places as on Beaverlodge lake north of lake Athabaska there are interbedded flows of amygdaloidal basalt. The strata have as a rule low dips but locally they have been gently folded and also faulted and brecciated. The series is cut by diabase dykes related to the volcanic flows, but nowhere has it been found to be intruded by granite.

As already mentioned parts of the Shield were covered in post-Proterozoic time by a capping of sediments deposited in seas which swept over portions of it during the Palaeozoic and Mesozoic eras. Except for some remnants along the borders to which reference will be made later these were removed by erosion during the Tertiary. The last great event in the history of the region was the spread of a continental ice mass in Pleistocene times. This had its gathering ground west of Hudson bay from which centre it advanced in all directions. Erratics and morainal material left by the ice are scattered over the entire region.

CORDILLERAN REGION

An area of some 30,000 square miles of the Northwest Territories west of Mackenzie river and between the Peel on the north and the Liard on the south forms part of the great Cordilleran region of Western Canada. The Mackenzie mountains, forming this region and a part of Yukon Territory are made up of ranges trending in a northwest direction and ranging in elevation up to over

Rainbow Arch of Carcajou River, an Anticline of Middle Devonian Strata

8,000 feet with a relief, where explored, of 3,000 to 4,500 feet. The drainage of the area under discussion is to the Mackenzie, the chief streams being Arctic Red river, the Carcajou, the Keele (formerly the Gravel), the Root, the North Nahanni and the South Nahanni, the last of which empties into the Liard. All of these streams have steep gradients. On the Keele river where the belt is widest the high mountains lie about 50 miles from the Mackenzie, and between them and the Mackenzie lowland is a zone of foot-hills about 3,000 feet in height. Farther south at the "Great Bend" of the Mackenzie near where the latter is joined by the North Nahanni, the mountain front is an abrupt unscalable escarpment the top of which is 2,000 to 3,000 feet above the valley plain.

The mountain belt is made up of two portions, a western and an eastern, which differ in form and structure. West of mount Sekwi, which lies near Keele river about 45 miles east of the Yukon boundary, the mountains have a

mature appearance, with wide valleys and the high peaks set well back from the valley bottoms. To the east the mountains are more massive and rugged and the streams are confined in narrow valleys with steep slopes of bare rock or of partly wooded rock and talus.

The rocks of the range are chiefly sediments of Palaeozoic age ranging from Upper Cambrian to Upper Devonian. They consist of shales, slates, cherty sandstone, conglomerate, limestone, and dolomite. In the western portion the sediments are intruded at various points by small masses of igneous rocks and a number of the higher mountain peaks consist of granite of probably Cretaceous age. The sediments of this section are dominantly dark coloured and in the main they trend to the northwest and dip at various angles to the northeast or southeast in broad folds, but locally the folding is close. There is also evidence of faulting and overturned folding.

The rocks of the eastern belt are heavily bedded limestones, dolomites, sandstones, and conglomerates, mostly weathering to bright colours. At the junction of Natla and Keele rivers, purple and greenish argillites overlain by dolomites, calcareous sandstone, and limestone have yielded a few fossils of the Cambrian age. These beds dip at a low angle to the southeast and have a total thickness of about 4,000 feet. The Tigonankweine range, where traversed by the Keele river, is built up of rocks of Ordovician age. These consist of about 4,000 feet of alternating beds of argillite, dolomite, and limestone, surmounted by about 1,500 feet of sandstone. Just below the sandstone is a sill of diabase about 100 feet thick which extends for several miles. The eastern part of mount Sekwi is composed of vertical limestones from which a few fossils identified as Silurian were collected. In the Nahanni-Root country bituminous limestones of Middle Devonian age and non-bituminous dolomite of probable Silurian age (Lone Mountain dolomite) reach a thickness of 2,500 feet. Nahanni peak, one of the striking mountain features to be seen by the traveller descending the Mackenzie, is composed of these Middle Devonian strata. Lying above the hard limestones are Upper Devonian shales which may have a thickness of as much as 2,000 feet and above these is a limestone zone 800 to 1,100 feet thick marked by the presence of Leiorhynchids. This in turn is succeeded by other shale and limestone facies 1,300 to 1,500 feet thick,

Nahanni Mountain showing Steep, Cliff-like Escarpment West of the Big Bend of Mackenzie River

all of Upper Devonian age. On the North Nahanni, the Middle Devonian rocks are seen to form an anticline with steep dips on the east and more gently inclined beds on the west.

The orogenic movements which built the Mackenzie mountains are believed to have taken place in the Cretaceous. They were accompanied by faulting on a large scale. Minor disturbances marked by change in elevation and mild deformation, including faulting, took place later probably in Miocene times.

In Pleistocene times the Mackenzie mountains were occupied by the northern extension of the Cordilleran glacier. The ice sheet had here a thickness of about 3,000 feet. The higher peaks were not covered.

THE INTERIOR PLAINS

The Mackenzie lowland includes the belt between the Cordilleran region on the west and the Canadian Shield on the east. It begins on Slave river, embraces the basin at the west end of Great Slave lake, and continues down to the Arctic coast. On Slave river its elevation is about 700 feet and from there northward the surface, which does not for the most part rise much above the level of the main watercourses, slopes gradually to the Arctic. North of Nahanni river the lowland is divided into two parts by the long, narrow ridge of Franklin mountains, a western portion varying in width from 20 to 80 miles through which the Mackenzie flows and an eastern portion occupying the drainage basin of Great Bear lake. Other elevations which rise above the general level of the lowland include: Horn mountain, northwest of Providence; Grizzly Bear mountain and Scented Grass hills on the shores of Great Bear lake; Reindeer hills, east of Mackenzie delta; and a number of other short ranges or isolated hills. The highest summit is mount Clark of the Franklin range which has an elevation of between 3,000 and 4,000 feet. The Franklin range is sometimes regarded as an outlier of the Mackenzie mountains, which does not cross the river but marks a separate line of orogenic movement.

The rocks exposed at the surface in the Mackenzie lowlands belong to the following systems:—

Eocene	Shales, sandstones and lignite.
Cretaceous	Clay shales and sandstones.
Devonian	Limestones, bituminous shales and sandstones.
Silurian	Limestones, dolomites, gypsum.
Ordovician (?)	Shales.
Cambrian	Quartzites, shales, sandstones.

Cambrian strata are exposed in the Franklin mountains. The Mount Clark formation consists of red quartzites and sandstones of probable lower Cambrian age. Above these lies the Middle Cambrian Mount Cap formation consisting of grey, green, and red sandstones and shales, while a third formation called the Saline River consisting of red and green shales with gypsum-bearing beds belongs either to the Middle or Upper Cambrian. Shale beds of possible Ordovician age are also exposed at the base of mount Kindle east of Wrigley and some red beds lying beneath Silurian dolomite in the Great Slave Lake region may also be of that age.

Rocks of Silurian age form the base of the Palaeozoic section along a considerable part of the eastern edge of the lowland belt where the Palaeozoic sediments overlap the Precambrian rocks of the Canadian Shield. Limestone and gypsiferous dolomite occur along Slave river and on the west side of the north arm of Great Slave lake, Silurian sediments form an escarpment which probably continues northward to Great Bear lake. Silurian strata are also exposed in Lone mountain near the mouth of North Nahanni river, in Bear mountain near Norman, and in mount St. Charles on Great Bear river.

The Silurian strata are succeeded unconformably by beds of Devonian age. These form the surface rocks over the greater part of the Mackenzie lowland region. They belong to two divisions of the Devonian, the Middle and the Upper. The Middle Devonian rocks consist of limestone with some shale beds. On Great Slave lake these strata have been divided into three formations, in ascending order: the Pine Point limestone, about 100 feet thick; the Presqu'ile dolomite with an estimated thickness of 200 feet; and the Slave Point limestone about 160 feet thick. Along the lower Mackenzie the following formations have been correlated with these respectively: the Hare Indian River shales, over 300 feet thick; The Ramparts limestone, 250 feet thick; and the Beavertail limestone, 350 feet thick. The Ramparts limestone is so named from its excellent exposures in The Ramparts section just above Good Hope.

The Upper Devonian sediments show a predominance of shales over limestones. They are divided into two formations in both the lower Mackenzie region and the Great Slave Lake and upper Mackenzie region. In the former the lower division is the Fort Creek shales consisting of from 500 to 1,000 feet of bituminous shales with thin beds of dark limestone and calcareous sandstone; the upper division is the Bosworth formation consisting of over 2,000 feet of greenish and vari-coloured clay-shales and sandstones. Both formations carry marine shells and plant fragments. In the latter region the corresponding formations are the Simpson shale correlated with the upper part of the Fort Creek formation and the Hay River limestone and shale correlated with the Bosworth formation.

Bear Rock, Norman.

Sandstones and shales of Cretaceous age cover considerable areas in the Mackenzie lowland region. They outcrop on Liard river near the southern border of the Territories, along the Mackenzie north of Dahadinni river in several disconnected stretches, and along the western shores of Great Bear lake. The beds are largely of marine origin but in places some of the lower strata carry coal seams. At the mouth of Bear river a basin of partly consolidated Tertiary sands and clay with lignite beds has a length of 30 to 40 miles and a width of from 20 to 30 miles. The beds are of lacustrine origin and of Eocene age.

The geological history and structure of the region may be briefly summarized. Evidently from the Proterozoic to the Tertiary, the Interior Plains and the eastern part of the Cordilleran region formed part of a single geological province which was to a great extent unaffected by mountain-building movements. Seas

advanced at different times over it from various directions and later retreated. At times as during the Upper Devonian, the Carboniferous, the Triassic, and the Jurassic, the greater part of the region at least was above the sea undergoing erosion. The advance and retreat of the various seas was due to repeated regional uplift and depression. In addition to these movements, there were probably periods of broad warping. One of these took place after the deposition of the Devonian beds and prior to that of the Cretaceous strata. In places, as in the Franklin mountains, the movement took the form of gentle folding. In very late Cretaceous or very early Tertiary times mountain building movements occurred in the Mackenzie mountains and the Franklin mountains. Later disturbances, apparently accompanied by block faulting in the Mackenzie mountains, took place in Tertiary time. In the Pleistocene the region was covered by ice. Along Mackenzie river deposits of glacial material have a thickness of at least 200 to 250 feet. Most of the ice was from the Keewatin centre of dispersal west of Hudson bay. It overrode the Franklin mountains and filled the Mackenzie valley. Here it was deflected northward by the barrier of the Mackenzie mountains. Cordilleran ice also advanced from these mountains eastward to the lowland area.

Cliff of Limestone of Great Slave Group, Et-then Island, Great Slave Lake

ARCTIC ARCHIPELAGO

The part of the Arctic archipelago with which this report is concerned includes the two large islands, Banks and Victoria. With them, however, will be discussed the portions of the mainland coast where the Precambrian rocks are concealed by younger strata.

But little is known of the geology of the two islands. Red sandstones occur along the south coast of Victoria island, and north of the Richardson islands red sandstones and limestones are intruded by sills of diabase. It is probable that all these rocks belong to the Coppermine series of late Precambrian age and that the formation extends along the whole central part of the south shore of the island and inland for a considerable distance. Palaeozoic limestones are believed to cover most at least of the remainder of the island. The south part of Banks island is reported to be underlain by Silurian beds. The larger portion of the

island is probably covered by Carboniferous strata which in places are known to carry seams of coal. On the northwest coast is an area covered by Tertiary deposits carrying plant remains of probable Miocene age.

Southwest of Victoria island a belt of thin-bedded grey cherty dolomites stretches along the mainland coast from the mouth of Rae river on the western side of Coronation gulf northwestward for a distance of about 150 miles to the vicinity of Tinney point. A few fossils found in some loose fragments indicate an age of Upper Cambrian or Lower Ordovician for at least some of the beds. Between this belt and Victoria island dolomites on Liston and Sutton islands have yielded Silurian fossils and similar dolomites occupy all of the western part of Victoria island. The dolomitic series also occurs on Parry peninsula where Silurian fossils were found in loose blocks on the western shore. The beds in general have low dips. At the western base of Tinney point the dolomites are overlain by a series of conglomerates and sandstones whose age is not known; it is apparently separated, however, from the supposedly Silurian beds by an erosion interval. Along Brock river for several miles above its mouth in Darnley bay occur Tertiary beds consisting of slightly consolidated light grey, dark grey, and brown shales containing lenses of fine-grained sandy limestones. These measures lie horizontally and have a total thickness of over 125 feet. Fossils indicate an upper Eocene or Oligocene age.

ECONOMIC GEOLOGY

The region contains a variety of mineral occurrences and a brief reference will be made to the more important. Considering the large proportion of the region which has not, as yet, been prospected or even explored these probably represent only a small part of its potential mineral wealth.

Gold

As already mentioned much of the Precambrian portion of the Northwest Territories consists of broad expanses underlain by granites and gneisses. Here and there, however, are patches of sediments and basic igneous rocks. Where these rocks are older than the granite they offer attractive possibilities to the prospector in his search for gold. A number of such areas are known to occur between lake Athabaska and Great Slave lake; others lie north of Great Slave lake in the Yellowknife River region, and farther north towards Great Bear lake. Still others are known on the west side of Hudson bay. These patches of older rocks are mere remnants of once widespread formations. Further exploration will undoubtedly reveal other such areas.

In the Yellowknife area deposits of gold were reported as early as 1898 and recently considerable interest has been attracted to the region. The gold has been found in quartz veins and in quartz stringers in schist. On Wilson and Outpost islands in Great Slave lake, claims have been staked on gold-bearing quartz veins cutting quartzite. Free gold has been found in quartz in a shear zone on Term island, south of Rankin inlet on the west coast of Hudson bay and other silicified shear zones in the old sedimentary complex have been located and investigated as possibly containing gold.

Recently in the Lake Athabaska region just south of the Territories boundary free gold has been found associated with a young Precambrian granite. The gold occurs in quartz stringers cutting the granite and in the granite itself. The occurrence is leading to a search for similar granite in other areas in this general region. Since it is possible that such granite may be found cutting the old granites and gneisses, formations which previously were considered as showing

little likelihood of yielding fruitful results, a wider field is thus offered for the activity of the prospector in his search for gold.

A number of placer claims have been staked on Liard river and on some of the streams tributary to South Nahanni river.

Pitchblende-Silver*

Important deposits of radium-bearing pitchblende, with which is associated silver, occur on the east side of Great Bear lake. The chief property is that of Eldorado Gold Mines, Limited, situated on Labine Point immediately north of Echo bay. The claims were staked from May, 1930 to 1931 by G. A. LaBine and others. This company ships concentrates and picked ore to its refinery at Port Hope, Ontario. In addition to the production of radium an important part of the refinery operations is the production of uranium salts. Other deposits of a similar nature have been found on Echo bay, on Camsell river which empties into Conjuror bay to the south of Echo bay, and also still farther south in the Hottah Lake region.

The rocks at LaBine point consist of fine-grained, banded sediments, volcanic agglomerates, some doubtful flow rocks, and impure limestone. Granite occurs along the west side of the point and on some small islands immediately to the north, and a small aplitic dyke, an offshoot from the granite, extends partly across the point. A basic sill, in places 200 feet thick, is intrusive into the sediments and volcanic rocks.

The pitchblende and silver are found in shear and shatter zones in the older rocks near their contact with the intrusive granite. The latter rock is probably the source of the mineralization. Work has been carried out on three zones a few hundred feet apart trending east-northeast. No. 1, the most southerly, lies partly under water along the shore of the lake; the middle one, No. 2, has been traced from the shore for a distance of 1,400 feet to a point under which it disappears; and the third, still farther north, has been followed for several hundred feet from the shore. In addition to the main zones, a second set of fractures trend slightly east of north, many of which branch from the main shear zones. This set is commonly occupied by quartz and carbonate veins, some of which have a width of 3 feet. There are also other small veins which do not belong to either system.

In the three main zones, quartz has cemented a breccia of the sheared rocks or forms a stockwork where the movement has been less extensive. Specular hematite is locally abundant in zone No. 1. Dark brown siderite and a yellow iron-bearing carbonate mineral are widespread. The pitchblende occurs as sinuous, persistent veinlets $\frac{1}{8}$ to 1 inch in width, as colloform masses in a matrix of dark quartz, and as angular fragments in a quartz matrix. The silver occurs as masses of wires in a reddish brown carbonate gangue and as plates and leaves, sometimes with carbonate, between the surfaces and in cracks of pitchblende and as plates in fractures and minute wires scattered through slightly fractured wallrock. Additional minerals in the shear zones include arsenopyrite, magnetite, hematite, pyrite limonite, chalcopyrite, bornite, covellite, tetrahedrite, native copper, malachite, azurite, galena, cerussite (?), sphalerite, argentite, ruby silver (?), skutterudite, cobaltite, rammelsbergite (?), erythrite, annabergite, native bismuth.

Copper

The Coppermine River series is an important potential source of copper. Native copper is known to occur on Coppermine river and on the islands of Bathurst inlet. It has also been reported on Victoria island about 40 miles northeast of the head of Prince Albert sound, and at a point about 60 miles east of

* D. F. Kidd: Geol. Surv. Canada, Summ. Repts. 1931, Part C, and 1932, Part C.

Bathurst inlet. On the Coppermine, the deposits occur in what are known as the Copper mountains, a belt of high country some 15 miles wide situated about 40 miles from the river's mouth. The belt presents the appearance of a plateau reaching elevations of 1,200 to 1,500 feet interrupted by a series of broken ridges which slope gently to the north but which are marked on their south sides by vertical cliffs of different heights. The mountains are composed of basaltic flows with interbedded zones of reddish conglomerate. The latter are more abundant in the upper part of the series. The individual flows vary greatly in thickness and their upper parts are commonly amygdaloidal, the amygdules consisting of calcite, zeolites, epidote, chlorite, quartz, and native copper. In places a network of calcite seams cuts the flows and some of these contain chalcocite. In addition to the copper contained in the amygdaloidal portions of the flows, some of which carry considerable percentages of the native metal, the matrix of the conglomerate contains copper introduced by replacement. In the drift immediately north of the copper-bearing rocks west of the river numerous large masses of copper have been found and it is quite possible that the region contains workable deposits.

In the Bathurst Inlet area the native copper occurs as minute flakes throughout the dense groundmass of the basalts, and as irregular grains and small masses filling or partly filling the vesicles near the upper surface of the flows. It also is found as veins occupying fissures and shatter zones in the basaltic flows. Few of these veins reach a width of 3 inches. Numerous analyses of samples collected by the Southern Party of the Canadian Arctic Expedition indicate that there is a tremendous tonnage of rock in this area carrying 0·01 to 0·25 per cent copper together with amygdaloidal material of undetermined amount carrying over 1 per cent copper as well as the copper in the veins. The deposits form an important reserve but under present conditions it would not be profitable to work them.

In addition to the native copper this northern area is known to have deposits of copper sulphides. In 1930 the Northern Aerial Exploration Company discovered chalcocite and bornite in fissure veins and replacement deposits in the Coppermine region. The chalcocite occurs both in the veins with quartz and carbonate gangue and as dissemination through the country rock. The veins vary in width from 3 to 6 feet and the proportion of chalcocite varies from low-grade material to massive chalcocite without any associated gangue material. One deposit of massive bornite was found to have a width of 12 feet. Dominion Explorers, Ltd., also located a number of copper sulphide deposits in this northern region. A quartz vein at Hunter bay, Great Bear lake, carrying bornite, chalcocite, and chalcopyrite appears to be of considerable size. On islands of the same bay a large body of altered porphyry was found to be mineralized with chalcopyrite, chalcocite, and bornite. Its average copper content is around 2·5 per cent. In Conjuror bay at the southeast corner of Great Bear lake a long break in fractured syenite was found to be mineralized with chalcopyrite, chalcocite, bornite, and specularite, and a second deposit in the same region consists of a large area of brecciated rhyolite intruded by syenite containing galena and chalcopyrite. None of these deposits can be worked profitably at the present time, but they indicate that the region is highly mineralized.

Lead-Zinc

Deposits of lead and zinc occur in the Mackenzie lowland region about 32 miles southwest of Resolution on Great Slave lake. The claims which have been staked lie on a flat sandy or boulder-strewn country standing about 200 feet above the lake. The underlying rock of the region is dolomite belonging to the Middle Devonian Presqu'ile formation. It apparently passes down into bituminous shale and shaly limestone which may represent the lower measures of that formation but more probably the upper part of the formation below

the Pine Point limestone. The dolomite containing the mineralization is commonly open and cavernous and in places is to a slight extent impregnated with petroleum. Rock outcrops in the area are few and as a result it is difficult to determine structure. The strata, however, appear to have been gently folded along a direction north 70 degrees east with minor pitches in either direction normal to the strike. The deposits so far located occupy the eroded crests of these low anticlinal rolls. Their surface is marked by sink-holes caused by solutions dissolving out the ore minerals more particularly the pyrite. These sink-holes have a maximum depth of about 20 feet and have obviously been formed in post-glacial time. The metallic minerals in the deposits are galena, sphalerite, and pyrite, with their oxidized products, smithsonite, yellow oxide of lead, and various brown and red hydrous iron oxides. Assays of silver as high as 7 ounces to the ton have been obtained but in general the silver values may be regarded as negligible.

There are five known mineralized zones. Within these the rock is everywhere more or less mineralized with higher grade material concentrated as horizontal impregnations along favourable beds or along vertical or inclined joint-planes. In places the ore is a breccia with the ore minerals occurring between fragments of the dolomite. The deposits are regarded as having their origin in zinc and lead-bearing minerals originally disseminated through parts of the Presqu'ile formation now removed by erosion or from some similarly eroded younger formation. Meteoric waters are believed to have taken the material into solution and to have redeposited it in the joints, bedding planes, and cavities of the high as 7 ounces to the ton have been obtained but in general the silver may be regarded as negligible.

Iron

On Great Slave lake deposits of specular iron occur in the pre-granite complex, and oolitic iron deposits occur in the sedimentary-volcanic series which overlies the granite and older rocks. None of these deposits are, however, of commercial importance.

The deposits of specularite which have attracted chief attention are situated on what are known as the Iron islands, 35 miles northeast of Resolution. The islands consist chiefly of quartzite striking slightly north of east and dipping 30 degrees to the southeast. The specularite is micaceous and occurs with quartz within the quartzite beds. A sample of one zone, 35 feet thick, on the south island gave a content of 29.667 Fe_2O_3.

The oolitic hematite beds are exposed at several places along 5 miles of shoreline on the east side of the narrows 5 miles north of Utsingi point. They occur in red and black shales with associated volcanics. Several exposures show thickness of from 10 to 30 feet of oolitic hematite associated with hematite-bearing shales and jasper. The iron content is probably low. At several other places in the lake similar deposits occur.

Oil and Gas

The Mackenzie lowland region contains two areas in which drilling has been carried out for oil. At Great Slave lake the results were negative but in the second field, that at Norman, some measure of success was obtained. Other areas in the Mackenzie basin are presumably underlain by oil-bearing rocks but owing to their inaccessibility have not as yet been tested.

The Norman field which lies about 50 miles northwest of Norman was drilled by the Northwest Company, a subsidiary of Imperial Oil Limited, and by the Fort Norman Oil Company. The lowland in this region is a narrow belt lying between the Norman range of the Franklin mountains on the east and the Carcajou mountains of the Mackenzie system on the west. Rock exposures are practically lacking except along the larger streams and in the mountains. The

strata include beds of Cambrian, Silurian, Devonian, Cretaceous, and Eocene age. As already mentioned the thickest formations are of Devonian age. The field lies along the west limb of the broad anticline which forms the Franklin mountains.

The No. 1 or Discovery well of the Northwest Company was drilled in 1920 on the east side of Mackenzie river at the mouth of Bosworth creek. A flow of oil was obtained at a depth of 783 feet from the Fort Creek shales. The well was later deepened to 1,025 feet. Though it is now capped its potential capacity at the present time is understood to be about 100 barrels a day. In 1921 the Fort Norman Oil Company drilled a well about 8 miles upstream from the above site. It was put down to a depth of 1,512 feet and although no commercial oil was secured a flow of gas estimated at 30,000 cubic feet per day was obtained between depths of 385 and 500 feet. The Bluefish well of the Northwest Company located on the east bank of the Mackenzie at the mouth of Bluefish creek was abandoned because of drilling troubles. No. "C" well of the same company drilled on the west bank of the Mackenzie (the course of which is here from southeast to northwest) south and slightly east of No. 1 was put down to a depth of 3,057 feet without finding oil. No. "D" location well was sunk on Bear island in 1921 to a depth of 2,304 feet. A small flow of oil was obtained at 1,945 feet from the contact zone of the Fish Creek and the Beavertail formations. In 1924-25, No. 2 well of the Northwest Company, 150 feet away from its No. 1, was put down to a depth of 1,602 feet. Oil was obtained at 936 and 1,063 feet amounting to about 100 barrels a day. The main flow was believed to be from the Fork Creek shales. The well was reopened in 1932 and a refinery installed. Oil is now being shipped to the mining interests in the Great Bear Lake area.

From what is known at present it does not appear that the prospects for a large production of oil from this region are very favourable. Certain formations, however, are undoubtedly oil-bearing and a number of horizons are of sufficient porosity to act as oil reservoirs. Future possibilities would appear to depend upon the finding of favourable structures such as minor anticlinal folds superimposed on the general structure of the region.

In the Great Slave Lake region oil seepages are known from two formations, the Pine Point and the Presqu'ile. In 1921-22 the Northwest Company drilled a well on the crest of a broad anticline at Windy point on the north shore of the lake. The well began in the Presqu'ile dolomite and penetrated the total thickness of the Palaeozoic below. No oil was located. In 1922 the White Beaver Oil Company drilled a well on favourable structure 15 miles south of Great Slave lake in the vicinity of Hay river. A strong flow of salt water was struck in the Presqu'ile formation but no oil was encountered.

Coal

Coal is known to occur on Banks island near Rodd head, 9 miles east of cape Hamilton on the north coast, and another seam is reported in the vicinity of bay of Mercy.

Deposits of coal are also known on the west side of Great Bear lake and in 1932 coal claims were staked by several parties. The locality is the west side of Douglas bay about 11 miles northwest of the end of Etacho point. This point lies between Keith arm and Smith arm and is formed by the east end of Scented Grass hills. The coal seams outcrop in bluffs along the shore at intervals for 1½ miles and also inland for half a mile along a small creek. The coal is associated with sand and clay. No determinable fossils have been found but the age of the deposit is considered to be Cretaceous or Tertiary. The coal has the chemical character and physical appearance of the Saskatchewan or Ontario lignites and ranks with them. At two places beds of lignite, 13 feet in thickness and of good quality were sampled. Outcrops also occur on the northwest shore of McVicar arm on the south side of Great Bear lake, on the west bank of the Mackenzie near Norman, and on Peel channel near Aklavik.

WATER POWERS*

In recent years aerial photographic surveys and explorations, stimulated by the general mining activity in the north, have greatly increased the amount and reliability of the information concerning the topography of the Northwest Territories. Many important rivers and lakes, which formerly were virtually unknown, have been mapped and comparatively accurate records of the available head have been secured.

In the Northwest Territories very few power surveys have been made and stream flow records are few and far between. However large areas have been surveyed by aerial methods in recent years so that the fall of the principal rivers and their drainage areas are quite closely established. Consequently, it is now possible to make a reasonably close estimate of the water power resources of the Territories. An ordinary minimum flow and an ordinary six-month flow per square mile of drainage area has been calculated, using as a basis the run-off of other northern Canadian watersheds in similar territory and where hydrometric records have been secured. That the flow thus estimated is reasonably correct is borne out by some recently secured flow records which approximate quite closely to the assumed figures. In some cases, no doubt, the available flow will be less than the estimated figure but in others natural or constructed storage facilities will permit the flow to exceed greatly that used in these estimates so that, probably, the overall figures will not be greatly in error.

Tentative estimates made on the above basis indicate a total of about 285,000 horse-power available under conditions of ordinary minimum flow with over 730,000 horse-power ordinarily available for six months of the year, none of which has yet been developed. This water power is on the mainland, chiefly in the Mackenzie District. Little is known of the water power resources of the Arctic islands, Franklin District, but these are believed to be unimportant. From present knowledge possibly the most attractive river in the Northwest Territories, from a water power standpoint, is the Lockhart which enters the east end of Great Slave lake. This river gathers its waters from a chain of large lakes and in its final course from Artillery lake to Great Slave lake has a descent of nearly 700 feet in a distance of twenty-five miles. Artillery lake and the other lakes above offer excellent opportunities for storage to equalize the flow of the river in its lower course.

The Taltson-Tazin River system which enters Great Slave lake from the south has numerous rapids and falls, the Twin Gorge falls on the Taltson being particularly notable with a reported total descent of 130 feet. Snowdrift river also to the south of the lake, although a comparatively small stream, is reported to have a descent of 500 feet in six miles and to offer considerable power possibilities. Hay river enters Great Slave lake from the west and about forty-four miles from its mouth two abrupt falls are situated, namely, Alexandra falls offering a concentration of 140 feet and Louise falls one of 52 feet. Such records as have been secured of Hay river, however, indicate that the flow is not great.

Farther north Great Bear river, where it cuts through the Franklin mountains, has rapids which afford a power head of possibly 25 feet with the enormous area of Great Bear lake available to equalize the flow. Camsell river, a tributary of Great Bear lake has been actually surveyed with a view to the development of power for mining purposes. At White Eagle falls a head of approximately 70 feet could be secured, the development of which would render

* *Water and Power Bureau, Department of Mines and Resources.*

over 4,000 horse-power available at ordinary minimum flow and over 10,000 horse-power for six months of the year. Camsell river issues from a series of lakes and it is stated that it would be feasible to secure complete regulation of the flow of the river, in which case considerably more continuous power than that indicated above could be secured.

At Virginia falls on South Nahanni river, a tributary of the Liard, there is a total head of over 300 feet which represents a power capacity of from 3,000 to 12,500 horse-power. Other possible power sites in this district are believed to exist on Liard and Peel rivers but no definite information is available.

There are a number of rivers which flow into the Arctic ocean some of which appear to have considerable power possibilities. Amongst these may be mentioned Coppermine river which has numerous rapids, and at Bloody falls, near its mouth, a head of about 80 feet could be concentrated. Back river, also flowing into the Arctic ocean, has numerous rapids and falls.

Of the rivers flowing eastward into Hudson bay, power sites of magnitude are indicated by the falls and rapids of Dubawnt river, and lesser possibilities exist on Kazan, Thelon, and Hanbury rivers.

The large power resources of Slave river near Fort Smith are also worthy of note. At two concentrations it is estimated that from 220,000 horse-power to 500,000 horse-power could be developed. Practically all this power is in Alberta but the sites are located virtually at the boundary so that the resulting power would be readily available for use in the Northwest Territories.

PRINTED AT THE OFFICE OF THE SURVEYOR GENERAL OTTAWA 1936

Canada, North West Territories and Yukon Affairs, Bureau of
Canada's western northland

DATE	NAME OF BORROWER.
19/12/52	M. Jackson EAC.
May 7/56	ILC National Capital Library (Eng) 7/6
Nov 8/56	M. Jackson Dept of History.
Nov. 28/56	M. Jackson Fac.
Feb. 2/57	C. Gershenovich grad